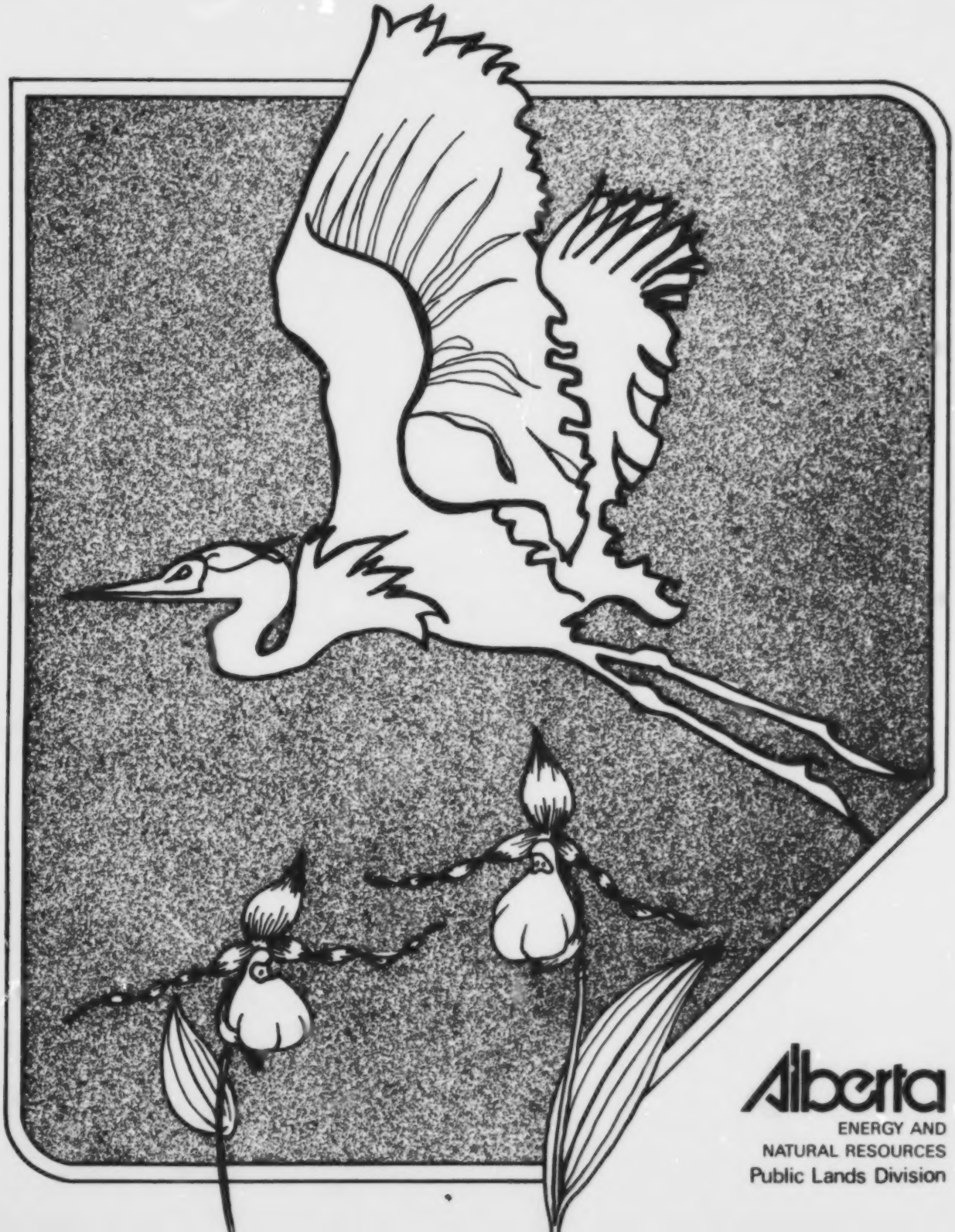
CONSERVATION VALUES AND MANAGEMENT CONCERNS in the Candidate South Castle Natural Area



Alberta
ENERGY AND
NATURAL RESOURCES
Public Lands Division

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CONSERVATION VALUES AND MANAGEMENT CONCERNS

in the Candidate South Castle Natural Area

by

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1986
Edmonton

Alberta
FORESTRY, LANDS & WILDLIFE
Public Lands Division

Forestry, Lands and Wildlife Technical Report Number: T/127
International Standard Book Number: 0-86499-369-2

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EXECUTIVE SUMMARY

The study area discussed in this report is a 1 170 ha site which includes within it a 260 ha candidate natural area. The site is on the southwest slopes of Whistler Mountain, near Pincher Creek in southwestern Alberta. The slopes are dry and support a mixture of open and closed coniferous forest, rockland and shrub communities. Two types of these shrub communities are dominated by Artemisia tridentata (Big Sage), which is rare in Alberta. The lowest slopes of the mountain, and the terraces of the Castle River at its foot, support deciduous and coniferous forests, as well as a third Artemisia tridentata habitat type. Together, these three Artemisia tridentata habitat types contain the largest known population of that species in Alberta. Furthermore, they appear to be unique among Artemisia tridentata communities in both Canada and the United States.

Three hundred and nineteen species of vascular plants were found in the study area. Eleven of these are rare in Canada and a further 25 are rare in Alberta. The size of the flora, and the number of nationally and provincially rare species is exceptional for such a small study area. The flora includes Tellima grandiflora (Large-flowered Fringecup), the first and only record of this species in Alberta.

Four of the rare plant species (Carex geyeri, Xerophyllum tenax, Habenaria unalascensis and Osmorhiza purpurea) occur within the study area and near, but not in the candidate natural area. The first two are nationally rare while the latter two are rare in Alberta. Several other rare species, including Arenaria nuttallii, Melica smithii, Ribes inerme, Ribes viscosissimum and Pyrola picta, are more common along the periphery of the candidate natural area than inside of it.

One unique vegetation type, Artemisia tridentata - Rhamnus alnifolia scrub, also occurs near but not in the candidate natural area. As well, unusual plant communities such as Populus tremuloides / Rubus parviflora - Osmorhiza chilensis forests and Fell-field Rockland are more abundant along the periphery of the candidate natural area than inside it.

The peripheral distribution of nationally and provincially significant rare plants and vegetation communities justify extensions of the current boundaries of the candidate natural area.

Brief annual inspections are recommended in order to monitor the impacts of recreation use, cattle grazing and forest disease. Further studies in the diverse subalpine meadows south of the candidate natural area are recommended because of the likelihood of finding populations of other rare species.

In conclusion, the candidate South Castle Natural Area and its environs are not typical of the Rocky Mountains, even in southwestern Alberta. Rather they are a unique meeting ground for species of the Pacific, Palouse, Mixed Grasslands, and Cordilleran biomes, and are of national significance. The region should be carefully managed to ensure its perpetuation in the interests of all who treasure our natural legacy.

ACKNOWLEDGMENTS

I would like to acknowledge the help of Peter Lee, Lorna Allen, and the rest of the staff of the Natural Areas Program, whose contributions to this study were innumerable.

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1. INTRODUCTION

The South Castle Natural Area has been proposed because of the occurrence of several plant species rare in Alberta. This report deals with the vegetation, flora and special features of the site. Major vegetation types are described and special attention is paid to the diversity of Artemisia tridentata communities within and adjacent to the candidate natural area. An annotated list of the vascular flora is provided, and rare species are noted. The special features include "classic" examples of vegetation types, rare biological features and areas of high biological diversity. Present and potential management problems are identified and recommendations are made for the maintenance of rare species and special features.

2. SETTING

2.1 Location of Study

The candidate South Castle Natural Area is in southwestern Alberta (Twp 4 Rge 3 W5: Sec 24), about 15 km southwest of Beaver Mines and 40 km southwest of Pincher Creek. It is about 260 ha in size and forms the core of a 1 170 ha study area considered in this report (Fig. 1). The larger unit was chosen in order to include the entire Big Sage community, and other special features associated with the central candidate natural area.

2.2 Physiography and Drainage

Elevations in the candidate natural area vary from 2 250 m in the northeast to 1 450 m in the southwest. Extreme (46 to 70 per cent) slopes predominate at higher elevations, but below 1 650 m the slope angle tends to decline, with nearly level (0.5 to 2.5 per cent) slopes on the Castle River plain. The main slopes face southwest, but northwest and southeast exposures dominate ravines associated with the two creeks which drain the area. These short creeks are intermittent through much of their upper reaches.

2.3 Geology

The candidate natural area is located on the south slope of Whistler Mountain, the northern tip of the Lewis Range. This range was formed during the Laramide Orogeny, when major thrust sheets were stacked in an imbricate manner over younger formations. The Lewis Thrust is the largest of these sheets, and can be traced from the Three Sisters of the Rundle Range (just south of the Bow River) down to Maria's Pass in northwestern Montana. In southwestern Alberta, the Lewis Thrust forced rocks of the Purcell Supergroup eastward over Upper Cretaceous strata, with only minor folding and faulting in the vicinity of the study area (Fig. 2) (Gordy et al. 1977).

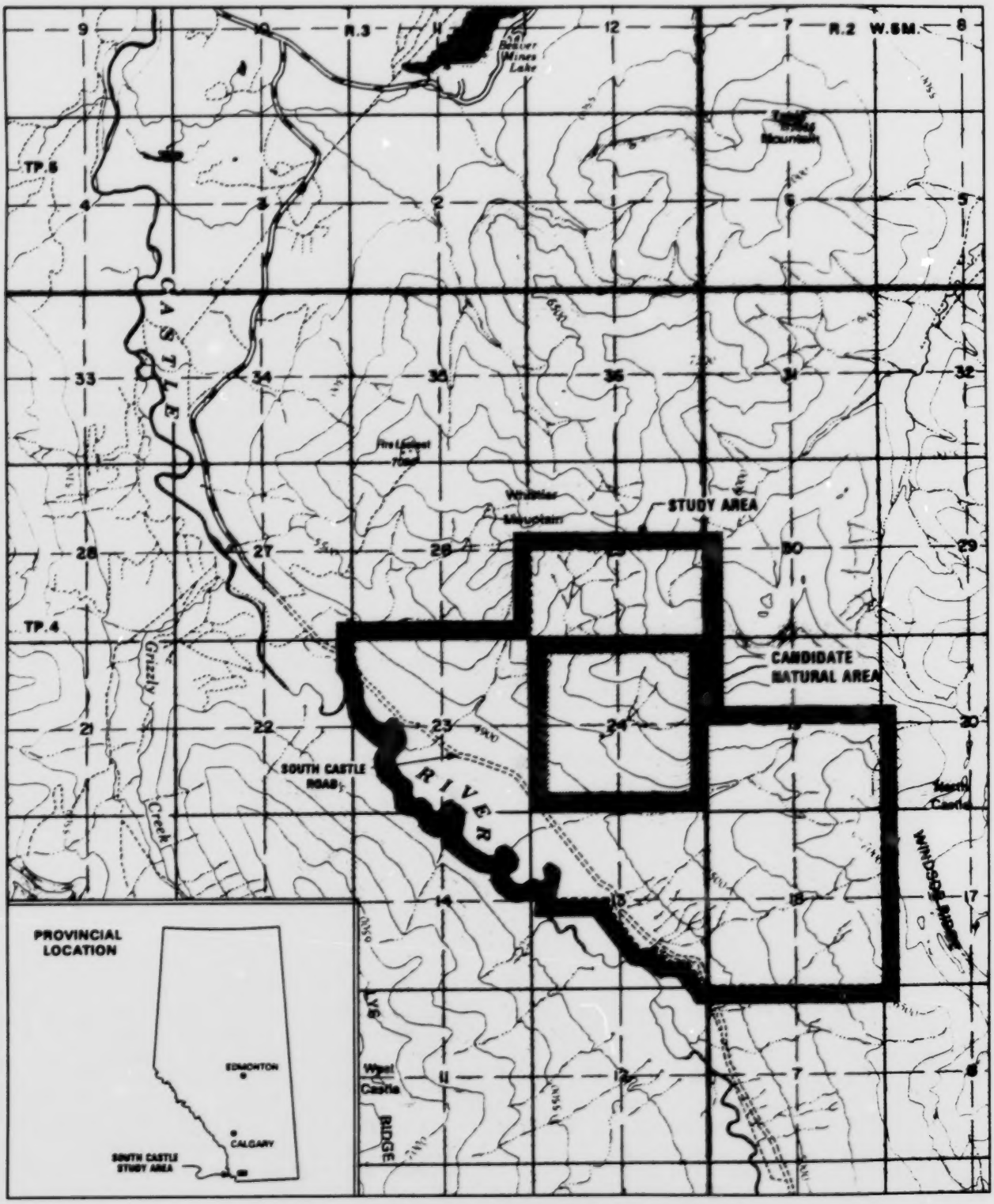

FIGURE 1 LOCATION OF THE SOUTH CASTLE STUDY AREA

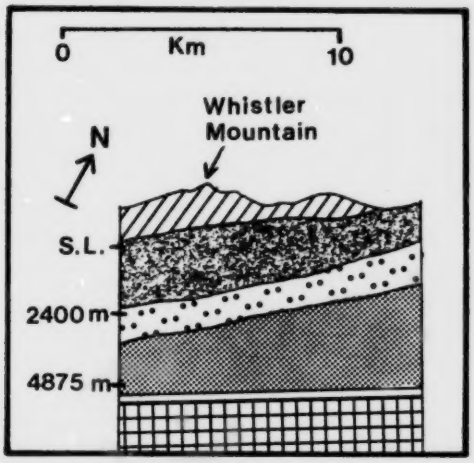

FIG. 2. STRATIGRAPHY
STRUCTURAL SECTION

SOURCE: From figure 11b in Gordy, Frey & Norris, 1977.

LEGEND:

- Precambrian Purcellian
- Upper Cretaceous
- Lower Cretaceous and Jurassic
- Mississippian and Devonian
- Cambrian
- Precambrian Shield

The Proterozoic (late Precambrian) Purcell Supergroup (known as the Belt Supergroup in the U.S.) consists primarily of sedimentary rocks, and is quite distinct from the older igneous and metamorphic basement which forms a sub-surface continuation of the Canadian Shield. The latter played no active role during the Laramide Orogeny. The supergroup consists of 3 400 m of shallow water and intertidal sedimentary rocks, which can be divided into two elements, separated by the Purcell Lavas. The older, lower element is dominated by clastics, while carbonates are largely restricted to strata overlying the lava (Gordy et al. 1977).

The bedrock (Fig. 3) of the study area consists of a sequence of formations of Purcell Supergroup beginning with the comparatively young Siyeh Formation in the northeast corner. This is the only noticeably calcareous bedrock in the candidate natural area, and consists of a series of limestone, dolomite and argillite layers. Andesite underlies most of the northern third of the area. This fine-grained dark lava with near-neutral pH comprises the Purcell Lavas. The Sheppard Formation of sandstone and siltstone (with some dolomite) forms the bedrock of a broad east-west band across the centre of the Area. The Kintla Formation sandstones, siltstone and argillites predominate along the southern edge. Normal faults lie to the immediate northwest, while thrust faults may be observed to the northeast and southwest. A series of anticlines and synclines occur west of the Castle River (Norris 1959).

2.4 Landforms and Soils

Bedrock outcrops, or is shallowly buried by colluvial veneers or blankets through much of the study area. Where soils have developed on these sites, they are generally Orthic Regosols. Below 1 650 m, thick till blankets are sandwiched between the underlying bedrock and thin colluvial veneers. These materials have developed soils with both chernozemic and brunisolic characteristics. Fluvial terraces border the Castle River, barely extending into the study area. They have a variety of soils reflecting the stability and moisture regime of individual sites. "Classic" examples of active alluvial fans occur where mountain creeks spill onto the river plain.

2.5 Climate

There are no climatic recording stations on site, so the following climatic description is based mainly on measurements from Beaver Mines (1 300 m). Data from a single station is obviously of less value in a mountain environment than it would be in a plains setting, because of the much more complex patterns of mesoclimate. For

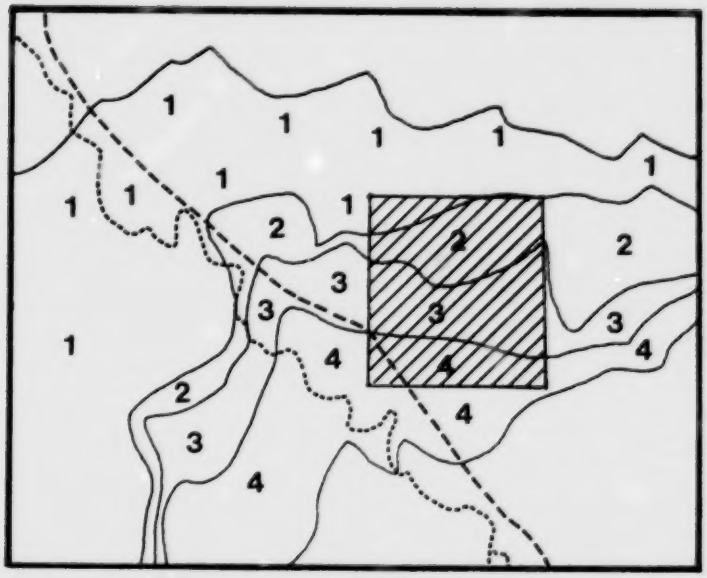

FIG. 3. BEDROCK GEOLOGY

SOURCE: From Norris 1958.

LEGEND:

- ▨ - Candidate Natural Area
- --- - South Castle Road
- ..... - South Castle River
1. Siyeh Formation – argillite, dolomite and limestone
2. Purcell Lavas – andesite
3. Sheppard Formation – dolomite, siltstone and sandstone
4. Kintla Formation – argillite, siltstone and sandstone

this reason, records from the Whistler Lookout (2 163 m) were considered despite their short duration and seasonal nature.

Climatic normals (Alberta Environment Service (AES) 1982) show that the region has warm summers and mild winters (Fig. 4). The high mean daily temperatures during winter reflect the frequency with which chinooks pass through the area. Degree days (Fig. 6) increase abruptly from April to the July-August peak, then decrease rapidly until November (AES 1982).

Daily maximum temperatures during the summer appear to decrease with an increase in elevation, however paired observations from Beaver Mines and Whistler Lookout (Fig. 5) in the summer of 1971 showed no significant difference in daily minimum temperatures (AES 1971).

The Beaver Mines station recorded a mean annual total of 207.6 mm of precipitation between 1951 and 1980 (AES 1982). Precipitation peaks in June, with a secondary peak in September (Fig. 7). The marked drop from June to July, along with a considerable increase in degree days (Fig. 6) (AES 1982) contribute to a pronounced late summer drought which is particularly severe on southwest slopes. Reliable wind data is not available for the area, however strong, dry, westerly winds typify the region and likely exacerbate the droughty conditions.

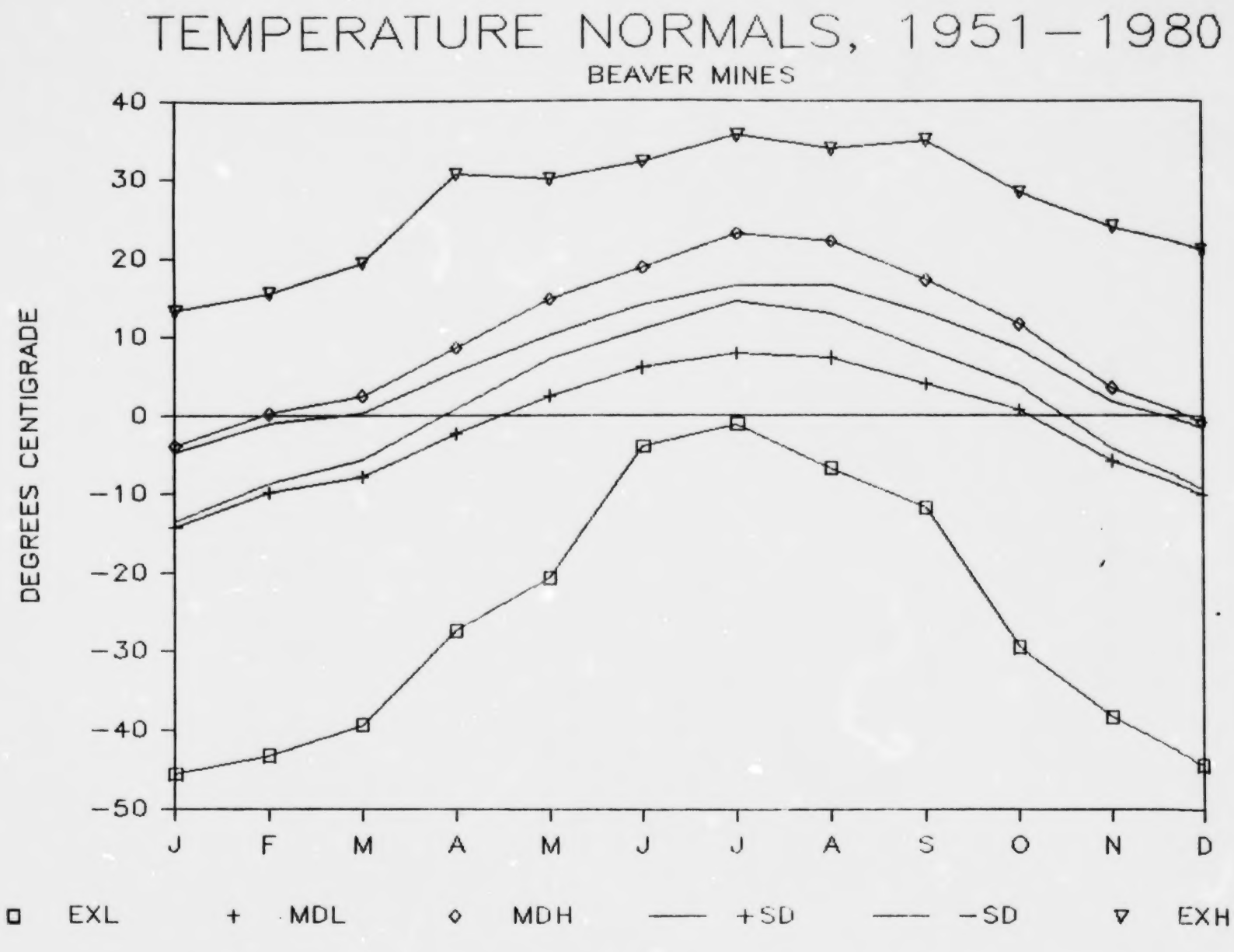

Fig. 4 TEMPERATURE NORMALS

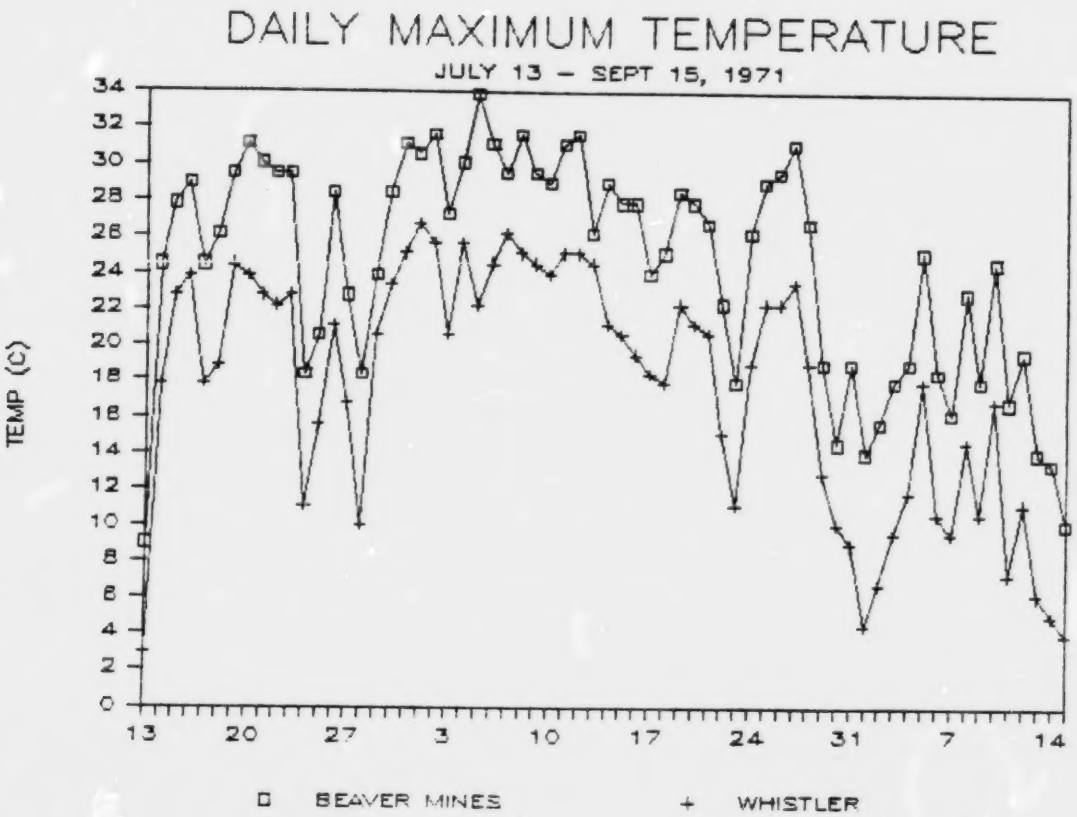

Fig. 5 DAILY MAXIMUM TEMPERATURE

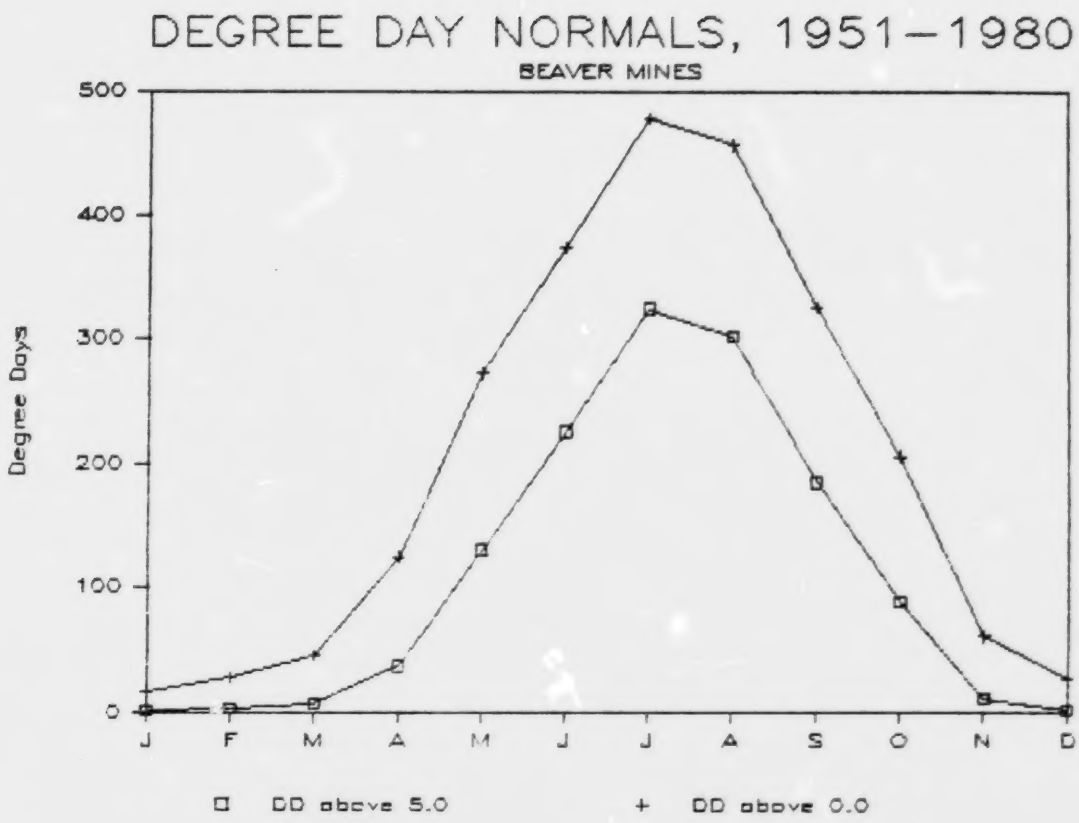

FIG. 6 DEGREE DAY NORMALS

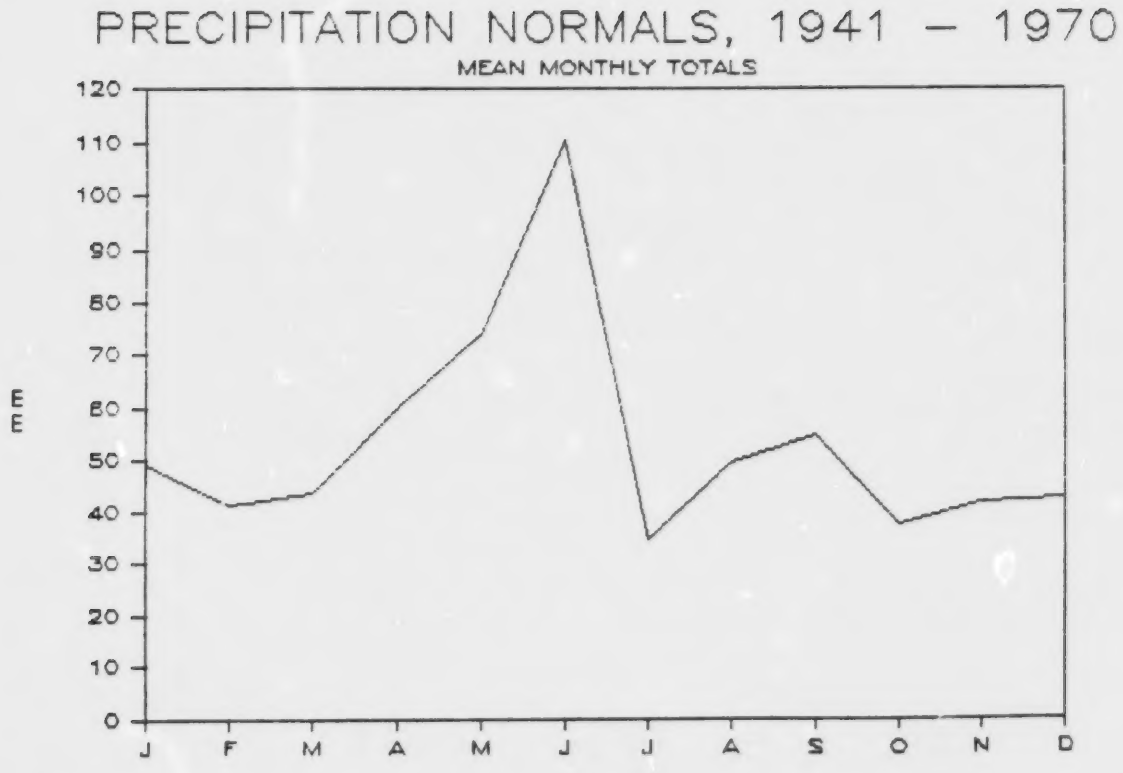

FIG. 7. MONTHLY PRECIPITATION NORMALS

3. METHODS

The Crowsnest Forest south of Highway 3 was reconnoitred by air in order to gain a regional perspective. Field investigations in the study area were conducted at roughly three-week intervals from mid May until early September in order to document seasonal biotic and abiotic phenomena.

Major vegetation types initially outlined on air photos were examined in the field. Sample plots were established in areas characteristic of each type. Forested plots were 20 m by 20 m, however 10 m by 10 m, and 5 m by 5 m plots were used in shrub and herb vegetation. Within each plot, canopy cover was estimated to the nearest per cent both for individual species, and for each stratum. Four strata were recognized: trees (over five metres tall), tall shrubs and saplings (two to five metres tall), medium shrubs and low saplings (0.5 to 2 m tall), low forbs (herbs, or shrubs less than 0.5 m tall), graminoids, and cryptogams (ground dwelling mosses and lichens). Cover values were also estimated for deadfall, litter, exposed mineral soil, and rocks and cobbles. The site elevation, aspect, slope angle, topographic position, relief shape, landform and apparent soil type were also noted, however no attempt was made to complete detailed soil descriptions.

Artemisia tridentata vegetation was examined in greater detail. Vegetation composition was sampled using a survey technique adapted from Mueggler and Stewart (1980). This involves estimating plant cover values in a large number of 25 cm by 40 cm quadrate within a 20 m by 20 m plot. The statistical error in the data was determined species by species, and the adequacy of this sampling intensity was evaluated using Husch's statistic (Husch et al. 1982, p. 165). The resulting values indicated that there were far too few samples to estimate mean cover values, even in the 20 m by 20 m plot, with an acceptable degree of certainty (a 10 per cent allowable error with a 95 per cent probability). Although these results led us to doubt the precision of other vegetation studies, the implications are beyond the scope of this study.

An attempt was made to estimate Artemisia tridentata age class distributions in each of the three habitats where it was prominent. The technique, adapted from Daubenmire (1975), involved examination of 40 stems from each site (the sample size was chosen arbitrarily). Growth rings were counted from stem sections collected at the base of each plant. In many cases the age of an individual could not be accurately measured because of rot in the woody tissues, or because the stem was only an offshoot of an older individual. When questionable

measurements were discarded, it proved impossible to determine age class distributions and compare habitat types. Although such data would be useful when investigating monitoring and management practices, the large sampling error indicated this technique could not be used for the relatively small stands of Artemisia tridentata in the study area.

Bird observations were noted during early morning excursions to major habitat types during the peak breeding season. These were supplemented by casual observations throughout the summer. No special trips were made to collect mammal observations, however sightings and sign were noted.

4. COMMUNITIES

4.1 Introduction

The distribution of community types in the candidate natural area and its environs is mapped in Fig. 8. Many map units consist of a mosaic of two or more community types, and their boundaries are often blurred. The approximate extent of each community type is noted in Table 1.

Table 1

EXTENT OF COMMUNITY AND HABITAT TYPES

Community or Habitat Type (H.T.)	% of Candidate Natural Area	% of Study Area
Pinus contorta Closed Forest	10-15%	30-35%
Abies lasiocarpa - *Pinus* Closed Forest	10-15%	10-15%
Populus Closed Forest and Thicket	1%	1%
Alnus - *Salix* Thicket	1-5%	1%
Rockland	50-70%	35-50%
- Lichen Scree H.T.	20-30%	15-20%
- Fell-field H.T.	1%	1-5%
- *Juniperus* Scrub H.T.	30-40%	20-25%
Artemisia tridentata Scrub	5-15%	10-20%
- *Saxifraga bronchialis* H.T.	1-5%	1-5%
- *Balsamorhiza sagittata* H.T.	5-10%	10-15%
- *Rhamnus alnifolia* H.T.	absent	1%

4.2 Pinus contorta Closed Forest

4.2.1 Distribution and Site Characteristics

Closed forests of Pinus contorta are widespread in the Montane zone, and to 1 900 m (6 350 ft.) in the Subalpine zone. Most stands above 1 700 m (5 650 ft.) occur on colluvial blankets on extreme (46 to 70 per cent) southwest slopes. These have developed loamy, stony, mesic to subxeric, well to rapidly drained soils. At lower elevations the dominant landforms are till blankets, often covered by colluvial or alluvial veneers. Slopes are gentle to strong (6 to 30 per cent), and soils tend to be similar to, but less stony than those of higher elevation stands. Similar pine forests also occur on fluvial fans in the Montane zone. These fans have moderate to very strong (10 to 45 per cent) slopes with a southwest aspect, and their soils are very stony and coarse-textured. As a consequence, the sites tend to be rapidly drained and subxeric.

4.2.2 Vegetation

Canopies tend to be closed, 10 to 15 m tall, and dominated by Pinus contorta. A small number of Picea glauca and/or Pseudotsuga menziesii are sometimes present, most often as saplings or seedlings. The canopies of the driest Pinus contorta closed forest communities, which occur on the subxeric fluvial fans described earlier, tend to be more patchy, and the trees are more widely spaced.

The subcanopy usually consists of scattered Alnus crispa, Shepherdia canadensis and conifer saplings. The stratum is most prominent on the few mesic sites which have an open tree canopy.

On dry sites such as the rapidly drained alluvial fans, the ground cover is open and dominated by xeromorphic dwarf shrubs including Juniperus communis, Arctostaphylos uva-ursi, Vaccinium caespitosum, Berberris repens and stunted Amelanchier alnifolia. Other frequent but less abundant species include Fragaria virginiana, Oryzopsis exigua, Aster conspicuus, Antennaria nitida, Galium boreale and Rosa spp. Xeromorphic mosses and lichen crusts are abundant on particularly stony microsites.

The ground cover of mesic sites usually consists of an open layer of tall forbs including Thalictrum occidentale, Rubus parviflorus, Symphoricarpos albus and Spiraea lucida over a more continuous mat of lower forbs and grasses including Vaccinium scoparium, Arnica cordifolia, Fragaria virginiana and Calamagrostis rubescens. Other frequent species include Epilobium angustifolium, Linnaea borealis, Vaccinium membranaceum, Vaccinium myrtillus, Aster ciliolatus, Aster conspicuus, Campanula rotundifolia, Chimaphila umbellata, Castilleja hispida, Erythronium grandiflorum, Viola orbiculata, Achillaea millefolium, Galium boreale, Hieracium

albiflorum, Pyrola asarifolia, Pyrola virens and Clematis verticellaris. Mosses and lichens are usually very scarce.

The transitions from Pinus contorta closed forest to Populus closed forest, Artemisia tridentata scrub and some phases of rockland vegetation (sections 4.4, 4.6, 4.7) are abrupt. The gradual change to Abies - Pinus closed forest (section 4.3) is marked by the presence of Abies lasiocarpa in the crown and subsidiary strata. As well, the abundance of Rubus parviflorus, Symphoricarpos albus, Spiraea lucida, Berberris repens, Arctostaphylos uva-ursi and Amelanchier alnifolia diminishes while Vaccinium membranaceum, Valeriana sitchensis, Goodyera oblongifolia, Clintonia uniflora, Erythronium grandiflorum and Ribes viscosissimum become more prominent.

Where Pinus contorta closed forests merge into Juniperus scrub rockland (section 4.6.2) or Artemisia tridentata - Saxifraga bronchialis vegetation (section 4.7.2), there is a decrease in Pinus contorta, Vaccinium caespitosum, Berberris repens, and Amelanchier alnifolia along with an increase in Saxifraga bronchialis, Heuchera cylindrica, Penstemon spp., Sedum spp. and Selaginella densa.

Similar Pinus contorta closed forest vegetation is reported for Waterton Lakes National Park (Kuchar 1973, Pinus contorta Forest Type). The most similar pine forests of Banff and Jasper National Parks (Type C3: Pinus contorta / Juniperus communis / Arctostaphylos uva-ursi, Type C6: Pinus contorta / Shepherdia canadensis / Aster conspicuus, Type C9: Pinus contorta / Vaccinium caespitosum, Type C18: Pinus contorta / Shepherdia canadensis / Vaccinium scoparium, and Type C19: Pinus contorta / Shepherdia canadensis / Linnaea borealis) tend to have much better developed moss carpets, and more Elymus innovatus and Shepherdia canadensis (Corns and Achuff 1982).

4.2.3 Fauna

Red Squirrels and Yellow-pine Chipmunks were the most frequently observed mammals in these pine forests, while Moose pellets were occasionally found near the edges. Pine Siskins, Chipping Sparrows, Dark-eyed Juncos, Golden Crowned Kinglets, Black Capped Chickadees, Yellow-rumped Warblers and American Robins were frequent and/or characteristic bird species.

4.2.4 Special Values

These pine forests are well represented within the study area. One nationally rare species (Osmorhiza occidentalis) and five provincially rare species (Lonicera utahensis, Habenaria unalascensis, Trisetum canescens, Ceanothus velutinus and Oryzopsis exigua) occur in these forests, and the first three were not found elsewhere in the study area (section 6). Oryzopsis exigua and Ceanothus velutinus were

found within the candidate natural area; the remaining six species were found only in the adjacent study area.

4.3 Abies lasiocarpa - Pinus Closed Forest

4.3.1 Distribution and Site Characteristics

Closed forests of Abies lasiocarpa and Pinus contorta and/or Pinus albicaulis are widespread in the Subalpine zone from 1 650 to 2 000 m (5 500 to 6 650 ft.). Most stands occur on moderately stable flaggy or rubbly colluvium, on sheltered strong to extreme (10 to 70 per cent) north or east slopes. Soils tend to be loamy, stony, subxeric to mesic, and moderately to very well drained, and are often subject to summer drought.

4.3.2 Vegetation

Canopies tend to be closed, 10 to 15 m tall, and co-dominated by two or more species. Abies lasiocarpa is ubiquitous, however Pinus albicaulis is most abundant above 1 750 m (5 850 ft.), while Pinus contorta is more prevalent at lower elevations. Picea engelmannii is scarce, and only occurs in a few older stands. Tree regeneration is slight in most stands, and generally consists of Abies lasiocarpa saplings or seedlings.

Stands on particularly dry sites, at elevations above 1 900 m (6 350 ft.), or on unstable soils tend to be more open and only 8 to 10 m tall.

The subcanopy, where present, is usually open and dominated by Alnus crispa and conifer saplings. A few cool, moist sites between 1 800 and 1 950 m (6 000 to 6 500 ft.) have open subcanopies dominated by Menziesia glabella and conifer saplings.

The ground cover of mesic sites is dominated by an open to closed assemblage of forbs including Vaccinium membranaceum, Arnica cordifolia, Thalictrum occidentale, Valeriana sitchensis, Goodyera oblongifolia, Clintonia uniflora, Erythronium grandiflorum, Ribes viscossimum and Viola orbiculata. Mosses and lichens are scarce. A very open ground cover of the same species occurs on the coolest, most heavily shaded sites, where Menziesia glabella often dominates the understory. The driest, warmest stands have a ground cover dominated by a dwarf shrub - xeromorphic herb - moss / lichen assemblage typical of rockland habitats (section 4.6.2).

The transitions from Abies lasiocarpa - Pinus closed forest to Populus closed forests (section 4.4.2), Artemisia tridentata scrub (section 4.7.2) and Alnus - Salix thickets (section 4.5.2) are abrupt.

Where it merges with Rockland (section 4.6.2) the change is more gradual and is most clearly marked by a decrease in size and abundance with, ultimately, the disappearance of trees. In Juniperus scrub rockland this is accompanied by the increased abundance of Saxifraga bronchialis, Heuchera cylindrica, Penstemon spp., Sedum spp. and Selaginella densa and the diminished prominence of most forbs typical of coniferous forests. Similar changes occur where it merges with lichen scree and fell-field rockland types.

The scarcity of low shrubs, herbs and bryophytes in Abies - Pinus / Menziesia stands in the study contrasts with their abundance in similar stands in Banff and Jasper National Parks (Type C12: Picea engelmannii - Pinus albicaulis / Menziesia glabella closed forest and Type C14: Picea engelmannii - Abies lasiocarpa / Menziesia glabella / Vaccinium scoparium closed forest, Corns and Achuff 1982, p. 86-87). The South Castle stands also differ from those in Waterton Lakes National Park, where Xerophyllum tenax is often subdominant to Menziesia glabella (Kuchar 1973, p. 154, 286-289). The more extensive, herb-rich Abies lasiocarpa - Pinus stands of the study area correspond to the Picea - Abies / Rubus parviflorus vegetation type found in Waterton Lakes National Park (Kuchar 1973).

The scarcity of Picea engelmannii in the study area and elsewhere in southwestern Alberta (Kuchar 1973, p. 153) contrasts with its co-dominance with Abies lasiocarpa in mature Subalpine forests in Banff and Jasper National Parks (Achuff 1982, p. 72). The dry climate of the study area may inhibit establishment by Picea engelmannii, for its shallow-rooted seedlings are more drought-susceptible than are those of Abies lasiocarpa (Daubenmire and Daubenmire 1968, Horton 1959). Where Picea engelmannii does become established, its low resistence to disease (Day 1972) may lead to rapid replacement by Abies lasiocarpa.

Pinus albicaulis, which grows over 15 m tall in the study area, is often perceived to be a "small alpine tree ... often reduced to a scrub" (Moss 1983). Day (1967) felt that the frequent occurrence of tall, straight individuals is characteristic of southwestern Alberta. This impression is contradicted by reports of tall Pinus albicaulis from Wyoming to Jasper National Park (Griggs 1938, Weaver and Dale 1974, Reed 1976, Pfister et al. 1977, Kuchar 1973, 1978, and Corns and Achuff 1982).

The species' elevational distribution may be unclear due to its close resemblance to Pinus flexilis, which prefers relatively low elevations. Day (1967) noted vigorous Pinus albicaulis regeneration as low as 1 370 m (4 500 ft.) in the Crowsnest area, however Kuchar (1973) places its lower limit at 1 675 m (5 500 ft.) in Waterton Lakes National Park. Furthermore, Kuchar considers its optimal range to be 1 830 to 2 130 m (6 000 to 7 000 ft.). He suggests its absence at lower elevations may be due to the effect of repeated fires "which favor lodgepole pine regeneration" (Kuchar 1973, p. 156). Pinus albicaulis may live for over 250 years in southwestern Alberta (Day 1972), and individuals in Wyoming are estimated to live as long as 2 000 years (Griggs 1938). This longevity, along with the ability to

regenerate successfully beneath forest canopies (Day 1972, pers. obs.), explain its presence in mature Subalpine stands.

4.3.3 Fauna

The mammalian and avian faunas of Abies lasiocarpa - Pinus closed forests resemble those of Pinus contorta closed forests, although some species (e.g., Townsend's Solitaire) tend to be more abundant in the former.

4.3.4 Special Values

Abies lasiocarpa - Pinus forests are widespread in the candidate natural area. Carex geyeri, which is rare in Canada, occurs in Abies - Pinus forests at the edge of the study area. It was not found in any other community type, and is not known from the candidate natural area. Three provincially rare species, Oryzopsis exigua, Ribes viscosissimum and Pyrola picta, were found in Abies - Pinus forests in the candidate natural area. All three were also found in other community types.

4.4 Populus tremuloides / balsamifera Closed Forest

4.4.1 Distribution and Site Characteristics

Closed forests and thickets of Populus tremuloides and/or P. balsamifera occur in small patches in the Montane and Subalpine zones to 1 710 m (5 700 ft.). These patches are found along creeks, at the toe of Whistler Mountain, and on more level areas of its lower slopes. Most stands below 1 450 m (4 850 ft.) occur on blankets or thick veneers of alluvium on very gentle to moderate (2.5 to 15 per cent) slopes. These materials form loamy to clayey, occasionally stony, mesic, moderately well drained soils. Above 1 450 m, compacted blankets of glacial till are the most frequent parent material. The sites occur on strong (16 to 30 per cent) southwest slopes. The tills have developed into loamy, slightly stony, mesic, moderately well drained soils.

4.4.2 Vegetation

Canopies tend to be closed or dense, 10 to 15 m tall, and dominated by Populus tremuloides. Picea glauca is occasionally present as seedlings or saplings, however tree regeneration is usually weak. Above 1 370 m (4 900 ft.) the canopy is much lower (four to six metres

tall), although scattered tall (to 20 m) Pseudotsuga menziesii may be present. Populus balsamifera tends to replace P. tremuloides on a few sites subject to seasonal waterlogging.

A subcanopy can sometimes be distinguished in Populus forests. It is generally very open and composed of scattered clumps of Crataegus douglasii and saplings of Pseudotsuga menziesii and Populus tremuloides.

The ground vegetation is generally dominated by a closed layer of tall, mesophytic forbs including: Amelanchier alnifolia, Thalictrum occidentale, Symphoricarpos albus, Rubus parviflorus, Osmorhiza chilensis and Actaea rubra. Other frequent, but less abundant species include Rosa woodsii, Galium boreale, Fragaria virginiana, Geranium viscosissimum, Viola rugulosa, Achillaea millefolium, Lomatium dissectum, Epilobium angustifolium, Clematis verticellaris, Erythronium grandiflorum, Hackelia floribunda, Ribes lacustre, Spiraea lucida, Castilleja miniata, and Smilacina stellata. Riparian bands of Populus balsamifera have a more variable ground cover reflecting a greater diversity of microsites. Uncommon plant species occurring in these microsites include Habenaria saccata and Senecio triangularis. Lichens are scarce in Populus forests, however wet microhabitats in Populus balsamifera stands are sometimes carpeted by mosses including Dicranum spp. and Campyllium stellatum. The transition to other vegetation types is abrupt.

Similar deciduous forests occur below 1 600 m (5 350 ft.) in the valleys of western Waterton Lakes National Park (Kuchar 1973). Aspen-dominated portions of northern Montana's aspen groveland also resemble the South Castle stands, and elements of all three of Lynch's (1955) associations (Populus tremuloides - Symphoricarpos albus; P. tremuloides - Aster foliaceus; and Populus tremuloides - Osmorhiza spp.) occur in the candidate natural area. Corns and Achuff (1982) describe four deciduous forest types in Banff, Jasper and Kootenay National Parks. Their most similar type of Populus tremuloides forests have a denser shrub layer composed of Rosa acicularis, Shepherdia canadensis and Juniperus communis, and a herb-dwarf shrub layer in which grasses (Elymus innovatus or Calamagrostis rubescens) are usually dominant. These differences, and the even greater ones between aspen forests in the South Castle study area and those of the interior plains of Alberta (Moss 1944, 1955 as described by Kuchar 1973), justify recognition of a distinct Populus community type in the Waterton-South Castle region.

4.4.3 Fauna

Moose and deer pellet groups were often found, and Whitetail Deer were observed twice at lower elevations in Populus forests. The most frequent birds include Western Tanagers, White-crowned Sparrows, Tree Swallows, Swainson's Thrushes, Pine Siskins, Chipping Sparrows and Lazuli Buntings.

4.4.4 Special Values

Populus forests and thickets are scarce in the candidate natural area and the study area as a whole. They contain one nationally rare (*Angelica dawsonii*) and five provincially rare species (*Habenaria saccata*, *Crataegus douglasii*, *Osmorhiza chilensis*, *Osmorhiza purpurea* and *Ribes inerme*) (section 6). Four of these (*Osmorhiza chilensis*, *Habenaria saccata*, *Crataegus douglasii* and *Osmorhiza purpurea*) do not occur in other habitat types and five species (*Angelica dawsonii*, *Habenaria saccata*, *Crataegus douglasii*, *Osmorhiza purpurea* and *Ribes inerme*) were not found in the candidate natural area.

4.5 Alnus - Salix Thickets

4.5.1 Distribution and Site Characteristics

Thickets of *Alnus* spp. and *Salix* spp. occur in a few scattered locations at low Subalpine elevations from 1 650 to 1 850 m (5 600 to 6 100 ft.). They are restricted to stable or active fluvial landforms with silty to gravelly, slightly stony, mesic to hydric materials. Gentle to moderate (5 to 15 per cent west or south facing slopes are favored.

4.5.2 Vegetation

Canopies tend to be closed to dense and three to six metres tall. Willows (particularly *Salix sitchensis*) tend to dominate along streams, *Alnus tenuifolia* favors slightly drier, more stable soils, and *A. crispa* dominates near the forest margin.

There is no characteristic ground flora, but a very open to dense mixture of tall mesophytic herbs and shrubs including *Heracleum lanatum*, *Thalictrum occidentale*, *Galium triflorum*, *Lonicera involucrata*, *Senecio triangularis*, *Ribes lacustre*, *Osmorhiza chilensis*, *Streptopus amplexifolius*, *Actaea rubra* and *Veratrum eschscholtzii* is most common. None of these species are consistently present, and the active, moist environments harbor several locally uncommon species, including *Polystichum lonchitis*, *Saxifraga occidentalis*, *Tolmachevia integrifolia*, *Sambucus melanocarpa*, *Circaea alpina* and *Mitella pentandra*. Shaded microsites often support a carpet of mosses including *Mnium* spp. and *Campylium stellatum*. The transition to other vegetation types is abrupt.

Alnus - *Salix* thickets have received uneven coverage in regional vegetation studies because of their limited extent. Corns and Achuff (1982) describe a *Salix scouleriana* - *Alnus crispa* / *Mertensia paniculata* type (S6) in Jasper National Park, occurring on subhygric to hygric lower Subalpine sites where slopes are moderate and a northerly

aspect prevails. Kuchar's Waterton Lakes National Park Study (1973) describes a similar Alder Avalanche Scrub type found in gullies, shallow draws, and steep uniform slopes with avalanching. In both cases, the vegetation is dominated by dense canopies of Alnus and/or Salix and the herb and moss layers are similar to those of the South Castle stands. Although Corns and Achuff (1982) and Achuff and Dudynsky (1984) make no mention of this type in Banff or Kootenay National Parks respectively, it is present in both parks (pers. obs.).

4.5.3 Fauna

There were few wildlife observations in this type because of its limited extent, and because it was not visited early enough to note breeding birds. Heavy Moose use was evident from the amount of browsing and the frequency of pellet groups. The avifaunas of willow thickets in Alberta tend to be diverse, and this is probably true for stands in the study area.

4.5.4 Special Values

Well developed examples of Alnus - Salix vegetation are scarce in the candidate natural area and the study area as a whole. One nationally rare (Angelica dawsonii) and five provincially rare (Salix sitchensis, Saxifraga odontoloma, Tellima grandiflora, Ribes viscosissimum and Orobanche uniflora) species occur in these communities (section 6). Salix sitchensis, Saxifraga odontoloma, Tellima grandiflora and Orobanche uniflora were not found in other community types. All but Angelica dawsonii were found in the candidate natural area.

4.6 Rockland

4.6.1 Distribution and Site Characteristics

Sparsely vegetated rockland is widespread at Alpine and Subalpine elevations above 1 650 m (5 500 ft.), and extends into the Montane zone as low as 1 590 m (5 300 ft.). Actively colluvial parent materials and exposed bedrock predominate, and where soils have developed they tend to be coarse-textured, very stony, xeric, and rapidly drained. Coarse fragments, which predominate, vary in form from angular to flat, and in size from gravelly to bouldery. Slopes tend to be strong to steep (16 to 100 per cent) and no aspect is favored.

4.6.2 Vegetation

The vegetation of stony and bouldery slopes is dominated by a xeromorphic Lichen Scree assemblage of crustose lichens, including species of Rhizocarpon, Lecidea and Lecanora, foliose lichens including Umbilicaria spp., and mosses such as Grimmia sp.

Channery and flaggy slopes above 2 050 m (6 800 ft.) usually support chionophobic Fell-field vegetation dominated by low clumped and/or oppressed forbs and grasses including Potentilla pensylvanica, Silene acaulis, Arabis lemmonii, Solidago multiradiata, Eriogonum androsaceum, E. ovalifolium, Carex rupestris, Dryas octopetala, Myosotis alpestris, Poa alpina, Festuca brachyphylla, Agropyron violaceum, Arenaria rubella, A. obtusiloba, A. nuttallii, Achillaea millefolium, Selaginella densa, Bromus inermis, Artemisia campestris and Oxytropis cusickii. Similar sites at lower elevations have very open vegetation dominated by stunted Populus tremuloides and Amelanchier alnifolia, and scattered herbs including Apocynum androsaemifolium, Achillaea millefolium, Potentilla glandulosa, Selaginella densa, Bromus inermis, Artemisia campestris, Campanula rotundifolia, Linum lewisii and Oxytropis cusickii.

Both bouldery and flaggy rockland often support Juniperus Scrub. Bouldery sites occasionally have a very sparse tree layer of scattered Pinus contorta, P. albicaulis, P. flexilis, and/or Abies lasiocarpa, or stunted Populus tremuloides or P. balsamifera. The open ground cover is dominated by Juniperus communis and/or J. horizontalis. Frequent but less abundant species include Saxifraga bronchialis, Heuchera cylindrica, Penstemon ellipticus, P. fruticosus, P. Tyallii, P. albertinus, Arctostaphylos uva-ursi, Cryptogramma acrostichoides, Rosa spp., Rubus strigosus, Acer glabrum, Potentilla glandulosum, Sedum stenopetalum, S. lanceolatum, Erigeron compositus and elements of the lichen scree type described previously.

4.6.3 Fauna

Bighorn Sheep, Moose, Golden-mantled Ground Squirrels and Least Chipmunks were all observed in Rocklands. The avifauna is varied, including Lazuli Buntings, Blue Grouse, Dark-eyed Juncos, Chipping Sparrows, Black-capped Chickadees, Common Crows, American Robins, White-crowned Sparrows, Pine Siskins, Golden Eagles, Common Flickers, Black-capped Chickadees, Townsend's Solitaires, Clarke's Nutcrackers, Yellow-rumped Warblers, and Hairy Woodpeckers.

4.6.4 Special Values

Rockland covers over half the candidate natural area. Most of this is Lichen Scree, which contains no nationally or provincially rare species.

Juniperus scrub is also extensive in the study area, and it contains five nationally rare (Calochortus apiculatus, Penstemon albertinus, P. eriantherus, P. lyallii and Senecio megacephalus) and five provincially rare (Oryzopsis exigua, Sedum stenopetalum, Ceanothus velutinus, Pyrola picta and Penstemon fruticosus) species. All of these species are present in the candidate natural area, and only five (Penstemon albertinus, P. eriantherus, P. fruticosus, P. lyallii and Senecio megacephalus) are restricted to Juniper scrub.

Fell-field habitats are scarce in the candidate natural area, and contain one nationally rare species, Arenaria nuttallii. It occurs within the candidate natural area, but is not found in any other community type.

One nationally rare species, Epilobium glaberriumum, and one provincially rare species, Mertensia longiflora, occur in intermittent stream channels running through rockland communities. Both occur in the candidate natural area and neither is found in any other community type (see section 6).

4.7 Artemisia tridentata Scrub

4.7.1 Distribution and Site Characteristics

Open shrubland dominated by Artemisia tridentata is widespread in the Montane and low Subalpine zones to 1 750 m (5 850 ft.), with patches as high as 1 850 m (6 150 ft.).

Most stands above 1 700 m (5 650 ft.) occur on 16-70 per cent southwest slopes. Stony, subxeric, rapidly drained colluvial materials are favored, soil development is weak and rock outcrops are frequent.

Stands between 1 450 to 1 700 m (4 800 to 5 650 ft.) usually occur on colluvial veneers over till blankets. Soils are loamy, weakly calcareous, and very stony. The coarse fragments are gravelly, channery, cobbly, flaggy and bouldery, and are most abundant (50 to 70 per cent by volume) at depths greater than 30 cm. Strong (30 to 50 per cent) southwest slopes are favored, and a microtopographic pattern of slight rises and shallow draws is common. These sites tend to be well drained and mesic (in draws) to xeric (on rises). Most rooting occurs in the top 30 cm, with very fine and micro roots as far as 80 cm below the soil surface.

The few stands found below 1 450 m (4 800 ft.) occur on very gentle (two to five per cent) alluvial terraces. Clay loam soils predominate, with widely varying proportions of coarse fragments. The sites tend to be subxeric to mesic.

4.7.2 Vegetation

The highest elevation stands comprise an Artemisia tridentata - Saxifraga bronchialis habitat type. The open ground cover is generally dominated by stunted Artemisia tridentata and includes a number of rockland species including Saxifraga bronchialis, Arctostaphylos uva-ursi, Potentilla glandulosa, Sedum stenopetalum and S. lanceolatum.

The intermediate elevation stands are the most extensive, and comprise an Artemisia tridentata - Balsamorhiza sagittata habitat type. Despite their homogeneous appearance on aerial photographs, these slopes support a varied vegetation. Slight rises tend to be dominated by low shrubs including Artemisia tridentata and Arctostaphylos uva-ursi along with a number of frequent, though less abundant forbs including Festuca idahoensis, Selaginella densa, Monarda fistulosa, Penstemon confertus, Linum lewisii, Eriogonum umbellatum, Sedum lanceolatum, S. stenopetalum, Senecio canus, Campanula rotundifolia, Agropyron dasystachyum and Prunus virginiana. Shallow draws usually support a more herb-rich assemblage dominated by Balsamorhiza sagittata and Lupinus sericeus along with less abundant species including Castilleja hispida, Lithospermum ruderale, Polemonium pulcherrimum, Oxytropis cusickii, Arabis holboellii, Viola adunca and Anemone multifida. The Artemisia tridentata - Balsamorhiza sagittata habitat type extends north of the study area (Fig. 8). Artemisia tridentata becomes increasingly scarce in the southern third of the candidate natural area and beyond, however similar habitat types without Artemisia tridentata occur even beyond the limits of the study area.

The lowest elevation stands, on river terraces, comprise an Artemisia tridentata - Rhamnus alnifolia habitat type. Artemisia tridentata dominates, while Rhamnus alnifolia is a frequent though less abundant associate. Cattle grazing has made herb identification difficult, however Fragaria virginiana, Penstemon confertus, Achillaea millefolium, Symphoricarpos albus, Phleum pratense, Agrostis scabra, Poa pratensis and Taraxacum officinale all appear to be prominent.

Artemisia tridentata scrub is gradually transitional to Pinus contorta closed forests, Abies lasiocarpa - Pinus closed forests, and rockland (see sections 4.6.2, 4.6.3 and 4.6.6 respectively), but the change to Populus forests and thickets (section 4.4.2) is generally abrupt.

Artemisia tridentata is a rare plant in Alberta, however it is widespread in the interior dry belt of British Columbia and throughout the western United States. The Artemisia tridentata communities of the Kamloops area were described by Spilsbury and Tisdale as early as 1944. They identified three grassland zones, along an elevational gradient. Artemisia tridentata is abundant in the lowermost zone, and occasional in the middle one. In both cases, Agropyron spicatum, Poa secunda, Stipa comata and Sporobolus cryptandrus dominate along with Artemisia tridentata and Antennaria dimorpha. Of these species, only Artemisia tridentata is prominent in the South Castle study area. In covering a larger area of grasslands in southern B.C., Tisdale (1947)

noted that Agropyron spicatum was dominant in Artemisia tridentata vegetation over the entire region. Again there was little floristic similarity with the South Castle study area. The vegetation of the Columbia Valley as described by McLean and Holland (1958) does not include Artemisia tridentata stands despite the existence of low elevation environments similar to those of the South Castle study area. Together, these three papers cover much of the interior dry belt of British Columbia. I examined easily accessible Artemisia tridentata vegetation throughout the dry belt of interior British Columbia in August 1985, and found no additional Artemisia tridentata vegetation similar to that of the study area.

Daubenmire (1952) described intermontane grasslands in his study of the vegetation of southeastern Washington and Idaho. He mapped a large zone characterized by an Artemisia tridentata - Agropyron spicatum climax in the western portion of his study area. As in B.C., the prominence of Agropyron spicatum contrasts strongly with the species' absence in the South Castle. None of the five south central Montana locations described by Wright and Wright (1948) resemble the South Castle site. Mueggler and Stewart (1980) studied the grassland and shrubland habitats of western Montana in great detail. Their Artemisia tridentata / Festuca idahoensis habitat type is the most similar to the South Castle stands. They occur on similar sites and contains many of the species dominant in the Balsamorhiza sagittata habitat type of the South Castle area, however the absence of Amelanchier alnifolia and Arctostaphylos uva-ursi and the abundance of Festuca idahoensis, clearly separate the Montana stands from those of the South Castle. Dr. Mueggler (U.S. Forest Service, pers. com., October 25, 1985) was unable to recall any U.S. stands similar to the Artemisia tridentata vegetation of the Castle River area, although there are structurally similar shrublands in the foothills of Colorado dominated by Artemisia tridentata along with congeneric counterparts of many species prominent in the South Castle stands (e.g., Symphoricarpos oreophilus, Amelanchier utahensis). I examined accessible Artemisia tridentata vegetation in Montana, Utah and Arizona (spring 1985), Idaho and Washington (August 1985), and found no communities comparable to the Artemisia tridentata habitat types of the South Castle.

Although the South Castle Artemisia tridentata vegetation appears to be unique, elements of the Palouse flora of the intermountain regions of B.C., Washington and Idaho (e.g., Festuca idahoensis, Balsamorhiza sagittata and Lithospermum ruderale) are present. Many of the prominent species in the South Castle stands which are absent in Artemisia tridentata vegetation elsewhere, are present in more mesic and/or higher elevation vegetation adjacent to those Artemisia tridentata stands (e.g., the Agropyron - Poa and Festuca - Agropyron zones of Daubenmire 1952, and the Mid- and Upper-Grassland zones of Tisdale 1947). The co-occurrence of drought tolerating (e.g., Sedum stenopetalum, S. lanceolatum, and Artemisia tridentata), drought evading (e.g., Lomatium macrocarpum, Collinsia parviflora, Balsamorhiza sagittata and Collomia linearis) and mesophytic species (e.g., Rosa woodsii, Symphoricarpos albus, Lithospermum ruderale, Delphinium bicolor, Stipa columbiana, Zygadenus venenosus and Geranium viscossisimum) in Artemisia tridentata stands in

our study area reflects a telescoping of gradients found elsewhere as well as a subtle and small-scale pattern of xeric and mesic microsites.

4.7.3 Fauna

Mule Deer, Elk, Moose, Coyote and Columbian Ground Squirrels are all characteristic of Artemisia tridentata vegetation in the study area, and the most frequently observed birds included Chipping Sparrows, White-crowned Sparrows, Blue Grouse, Brewer's Sparrows, Mountain Bluebirds, Brewer's Blackbirds, Lazuli Buntings and Calliope Hummingbirds.

The Artemisia tridentata - Balsamorhiza sagittata stands have been designated as critical wildlife zones due to the exceptional degree of summer use by ungulates (Alberta Forest Service n.d.). Pellet groups of Elk and Mule Deer are so numerous that attempts to estimate use were abandoned. Low shrubs, particularly Amelanchier alnifolia, are heavily browsed although Artemisia tridentata is not touched.

4.7.4. Special Values

The Saxifraga bronchialis and Balsamorhiza sagittata habitat types are well represented in the candidate natural area, however the Rhamnus alnifolia habitat type only occurs south and west of its boundaries. All three are nationally, or perhaps internationally, rare (see section 4.7.2). One nationally rare (Calochortus apiculatus) and five provincially rare (Sedum stenopetalum, Ribes inerme, Ceanothus velutinus, Castilleja hispida and Artemisia tridentata) plant species occur in Artemisia tridentata scrub, and of these only Ribes inerme is absent from the candidate natural area.

5. MANAGEMENT ISSUES

5.1 Pine Bark Beetle

Pine Bark Beetle (Dendroctonus ponderosae) pose an indirect threat to the candidate natural area because they may have to be controlled by logging infested or susceptible stands. The wood-boring larvae carry a fungal symbriant which attacks sapwood, decreasing the host tree's vigor. Needles on infested trees undergo a gradual color change the year after attack, however browning foliage may reflect other factors. Boring dust or pitch tubes at beetle entrance holes provide conclusive evidence (Safranyik et al. 1974).

Infestations have been reported along much of the Castle River (Moody and Cereske 1985), and I found several infected trees in low elevation Pinus contorta forests in the candidate natural area. Severely infested stands south of the Crowsnest Pass are candidates for sanitary logging by the Alberta Forest Service (Moody and Cereske 1985).

The loss of Pinus contorta stands in the candidate natural area would threaten the existence of rare species (section 6) restricted to this habitat type (Osmorhiza occidentalis, Lonicera utahensis and Habenaria unalascensis). The Pinus contorta stands along the South Castle Road also serve as a visual buffer for the unique Artemisia tridentata - Balsamorhiza sagittata scrub community (section 4.7.2) that might otherwise be damaged by all terrain vehicle use (section 5.3).

Infestations in southwestern Alberta appear to be on the wane (H. Cereske, Canadian Forestry Service, pers. com., May 1985), however the majority of low elevation pine stands in the study area are monocultures roughly 50 years old (pers. obs.). These characteristics will make them increasingly susceptible to future infestations (Safranyik et al. 1974).

The status of Mountain Pine Beetle can be monitored using timber cruising techniques (Safranyik et al. 1974). Infested stands can be managed using insecticides or by selective or clear-cutting. Lindane and ethylene dibromide have been used to control Mountain Pine Beetles, however the treatment is expensive and requires skilled applicators to work on a stem-by-stem basis (Safranyik et al. 1974). Mechanical control has been recommended where more than 2.5 trees per hectare are infested. All pine trees with a diameter (dbh) greater than 20 cm should be cut no more than 30 cm from the ground. They

should be felled in early summer, before beetle flights, and cut stems should be hauled out. Bark, edgings and infested logs should be burned to eliminate beetle larvae and the stand should be resurveyed for at least two years to ensure that the infestation has been checked (Safranyik et al. 1974). Tree-felling may also be an effective preventative measure, since reduced canopy densities tend to increase the resistance to infestation in remaining trees (Waring and Pitman 1985).

5.2 Cattle Grazing

Cattle grazing poses a direct threat to the study area both through trampling and selective feeding. The effects of grazing are evident in the forests and openings between the Castle River and the South Castle road, and for a short distance upslope of the road.

Grazing in river terrace openings threatens the entire Artemisia tridentata - Rhamnus alnifolia habitat type. This unique vegetation is already riddled with eroded cattle tracks, and most herbaceous species are unidentifiable due to grazing. Non-native species (e.g., Taraxacum officinale and Phleum pratense) and native ruderals (e.g., Agrostis scabra) are among the most abundant identifiable species, and appear to thrive because of their ability to tolerate grazing. The effects of cattle on Artemisia tridentata itself are less clear. The species is unpalatable (West et al. 1984, McLean and Tisdale 1972) and may benefit from the elimination of competitors. Whether or not this is true in the study area requires confirmation.

The effects of trampling are pronounced in some Populus forests on the river terraces. Vegetation shifts are not as pronounced in these habitats as they are in the Artemisia tridentata stands. Cattle activity does pose a continuing threat to populations of rare plants, including Osmorhiza chilensis, Habenaria saccata, Crataegus douglasii and Osmorhiza purpurea, which were not found in other habitat types in the study area (section 6).

Low elevation Pinus contorta forests are only lightly grazed, even where salt blocks have been left for cattle. Increased use in these pine forests may lead to cattle incursions into the unique Artemisia tridentata - Balsamorhiza sagittata communities above, which are not presently used by cattle.

The extent and impact of cattle grazing may be monitored by comparing levels of use allowed by the Alberta Forest Service to changes in the density of cattle tracks and the composition of vegetation in the preferred areas. Large (20 m x 20 m) exclosures could be monitored to identify the direction and rate of recovery in the absence of grazing, and to evaluate the influence of cattle on the presistence of the nationally rare Artemisia tridentata - Rhamnus alnifolia habitat type.

There are no obvious methods to mitigate cattle grazing damage aside from lowering the intensity of use or fencing high priority habitats.

5.3 Informal Recreation

Recreation use has had a direct impact on natural communities adjacent to the South Castle road. Informal motor camping and all terrain vehicle use have led to soil compaction and erosion and are probably responsible for changes in the composition and structure of some plant species.

Shrub vegetation is most severely disturbed. Large openings in the vicinity of the unique Artemisia tridentata - Rhamnus alnifolia stands are heavily used by trailer campers. The most obvious result is a network of vehicle tracks. More subtle changes to the vegetation are probably masked by the pervasive impacts of cattle grazing. Continued use will add to the pressure on this rare vegetation type.

No signs of all terrain vehicle use were noted in the Artemisia tridentata - Balsamorhiza sagittata scrub which occurs above the South Castle road, however similar areas north of the study area are rutted with bike trails. Many trail bikers camp in openings separated from Artemisia tridentata - Balsamorhiza sagittata scrub by only a thin band of Pinus contorta forest. It may only be a matter of time before they begin using the open slopes above. This scrub community is unique, and supports populations of four rare plant species (section 7.2) which may become threatened by heavy bike use.

5.4 Fire

Fire has had a profound effect on the study area, maintaining pioneer Pinus contorta stands throughout much of the forested portion of the study area (c.f. Rowe 1972). Tree cores indicate that most pine forests at lower Montane elevations are less than 70 years old. In the absence of further fires differential rates of succession will eventually lead to the development of a mosaic of coniferous forest types. This will increase the diversity of plant species and vegetation, and will decrease the likelihood of serious Pine Beetle infestations (section 5.1). Conversely, fires could eliminate the rich and varied Abies lasiocarpa - Pinus forests (Rowe 1972) of cool, moist slopes and higher elevations leading to a decrease in diversity.

Populus forests and thickets are also perpetuated by fire (Rowe 1972). In its absence they will probably be replaced by less diverse coniferous forests of Pseudotsuga menziesii and Picea glauca, and rare

species such as Osmorhiza chilensis, O. purpurea, Habenaria saccata and Crataegus douglasii may disappear from the study area.

Artemisia tridentata is eliminated by fire (Daubenmire 1975), yet the xeric vegetation types in which it occurs probably ingite easily. The scarcity of fuels and the presence of creeks acting as natural fire breaks may protect the Artemisia tridentata - Balsamorhiza sagittata and Artemisia tridentata - Saxifraga bronchialis habitat types. There is little evidence to suggest that Pinus contorta can successfully invade these habitat types. Populus spp. do appear to be invading Artemisia tridentata - Balsamorhiza sagittata and Artemisia tridentata - Rhamnus alnifolia habitat types, but it is not clear how far this can continue. Thickets of Populus tremuloides in the former habitat type are associated with old burnt stumps and isolated tall Pseudotsuga menziesii and may represent pioneer succession after fires in isolated patches of forest. Heavy browsing by ungulates appear to be limiting Populus growth elsewhere in the scrub habitat. The successional role of Populus spp. in Artemisia tridentata - Rhamnus alnifolia communities will be difficult to ascertain unless cattle grazing and recreation activities are eliminated.

6. RARE PLANT SPECIES

6.1 Introduction

The first Alberta specimen of Tellima grandiflora was collected during the course of this study, and 35 other provincially rare species were observed. There is some dispute over what constitutes a "rare species", however the National Museum of Natural Science has published a series of summaries including one for Alberta (Argus and White 1978) and British Columbia (Straley et al. 1985). Packer and Bradley (1984) adopted similar criteria in a separate checklist of rare plants in Alberta. Further references to these papers will be listed as A&W, STD or P&B respectively. There is no up-to-date list of nationally rare species. Some of the plants found in the natural area should be considered nationally rare, because they are listed as rare in both British Columbia and Alberta, and occur nowhere else in Canada.

The following list enumerates all species found in the study area which are considered rare in Alberta by either Packer and Bradley or Argus and White, and presents relevant information on their distribution. The terms "occasional", "frequent" and "widespread" denote an increasing likelihood of occurrence in patches of the indicated habitat(s). "Scarce", "common" and "abundant" denote an increasing prominence where the species occurs. These terms were applied subjectively, however "occasional" and "scarce" (when applied to provincially rare species) were intended to flag species deserving special attention.

6.2 Nationally Rare Plants

Carex geyeri P&B STD

Not mentioned by A&W, however P&B only maps two sites in Alberta, and STD only maps three sites in B.C., therefore national rare status seems appropriate. Total range: extreme southeast B.C and southwest Alberta south to northern California, Utah and Colorado. Occasional in open coniferous forests of the Subalpine zone, but not found in the candidate natural area.

Calochortus apiculatus A&W STD

Not mentioned by P&B, while Packer (Moss 1983) shows only three locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to northeastern Washington and northwestern Montana. Frequent in Artemisia tridentata scrub, open Montane pine forest, and coniferous scrub in the candidate natural area.

Xerophyllum tenax P&B STD

Not mentioned by A&W, but P&B only maps two locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to northwestern Washington, central California east to Montana. Scarce in moist Subalpine openings. Absent in candidate natural area.

Arenaria nuttallii A&W P&B STD

Two Alberta locations noted by P&B. Total range: southern B.C. and southwestern Alberta to California, Nevada, Utah, Wyoming. Frequent on flaggy and channery colluvial slopes, present in candidate natural area.

Epilobium glaberrrimum A&W P&B STD

One Alberta location shown by P&B. Total range: southern B.C. and southwestern Alberta to California, Utah, Montana. Scarce along seasonally wet stream courses, one location in candidate natural area.

Angelica dawsonii A&W STD

Not mentioned by P&B, while Packer (Moss 1983) shows six locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to northern Idaho and northwestern Montana. Occasional in moist forests from Montane to Subalpine zone. Absent in candidate natural area.

Osmorhiza occidentalis A&W STD

Not mentioned by P&B, while Packer (Moss 1984) shows five locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to western Montana, southern Colorado, central California and northwestern Wash. Frequent in wet-mesic Montane pine and poplar woods. Not found in but likely to occur in candidate natural area.

Penstemon albertinus A&W STD

Not mentioned by P&B, while Packer (Moss 1983) shows five locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to western Montana and central Idaho. Scarce in rockland, present in candidate natural area.

Penstemon eriantherus P&B STD

Not mentioned by A&W. P&B shows five locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to North Dakota, Nebraska, Oregon and Colorado. Scarce in rockland, present in candidate natural area.

Penstemon lyallii A&W STD
Not mentioned by P&B, while Packer (Moss 1983) shows five locations in Alberta. Total range: southeastern B.C. and southwestern Alberta to Montana, Idaho and E. Washington. Scarce in rockland, present in candidate natural area.

Senecio megacephalus A&W P&B STD
One Alberta location shown by P&B. Total range: southeastern B.C. and southwestern Alberta to west-central Montana and Idaho. Occasional in upper Subalpine rockland, present in candidate natural area.

6.3 Provincially Rare Plants

[number of locations mapped by Packer (Moss 1983) shown in brackets]

Melica smithii A&W P&B [2]
Scarce in moist Subalpine draws.
Scarce in candidate natural area.

Oryzopsis exigua A&W P&B [2]
Frequent in lower Subalpine coniferous scrub and rockland.
Abundant in candidate natural area.

Trisetum canescens A&W P&B [1]
Occasional in Montane pine forest.
Not found in but likely to occur in candidate natural area.

Habenaria saccata A&W P&B [2]
Scarce along Montane streams.
Not found in candidate natural area.

Habenaria unalascensis P&B [4]
Scarce in Montane pine forest.
Not found in but likely to occur in candidate natural area.

Salix sitchensis A&W P&B [1]
Frequent in willow-alder thickets.
Locally abundant in candidate natural area.

Draba densifolia A&W P&B STD [1]
Also present in northern Canada.
Scarce in upper Subalpine rockland.
Scarce in candidate natural area.

Draba verna A&W [not mapped]
Scarce in disturbed Montane areas.
Scarce in candidate natural area.

Sedum stenopetalum P&B [2]
Frequent in Artemisia tridentata scrub and rockland.
Frequent in candidate natural area.

Saxifraga odontoloma A&W P&B [2]
Scarce in rocky seeps.
Scarce in candidate natural area.

Tellima grandiflora First record for Alberta.
"... from the E Aleutian Is. and S Alaska through B.C. (E to the Selkirk Mts.) to Oregon and Idaho" (ex Scoggan 1978 p. 895). Taken literally, this means that the local population represents a range extension across the Rockies, the Purcells, and possibly over most of the Selkirks. It was found in an isolated location, therefore it was probably not introduced by people.
Scarce in rocky seeps.
Scarce in candidate natural area.

Ribes inerme A&W P&B [1]
Occasional in Artemisia tridentata-Rhamnus alnifolia scrub and along creeks.
Not found in but likely to occur in candidate natural area.

Ribes viscosissimum A&W P&B [3]
Occasional in cool coniferous woods and along streams.
Occasional in candidate natural area.

Crataegus douglasii A&W P&B [5]
Occasional in poplar forest.
Not found in but likely to occur in candidate natural area.

Ceanothus velutinus A&W P&B [3]
Frequent and widespread in rockland, poplar forest, pine forest and Artemisia tridentata scrub.
Frequent in candidate natural area.

Osmorhiza chilensis P&B [4]
Occasional in poplar woods.
Occasional in candidate natural area.

Osmorhiza purpurea A&W P&B [4]
Occasional along streams.
Not found in candidate natural area.

Pyrola picta A&W P&B [1]
Scarce in Subalpine pine forests.
Scarce in candidate natural area.

Mertensia longiflora A&W P&B [1]
Scarce along seasonally moist Subalpine streams.
Scarce in candidate natural area.

Castilleja hispida P&B [4]
Widespread in Montane pine and Artemisia tridentata scrub.
Widespread in candidate natural area.

Penstemon fruticosus A&W P&B [4]
Scarce in rockland.
Scarce in candidate natural area.

Orobanche uniflora A&W P&B [3]
Scarce in willow-alder thickets.
One location in candidate natural area.

Lonicera utahensis P&B [3]
Occasional in Montane pine forests.
Occasional in candidate natural area.

Artemisia tridentata A&W P&B [2]
Widespread in Artemisia tridentata scrub.
Widespread in candidate natural area.

Balsamorhiza sagittata A&W [9]
Widespread in Foothills Grassland and in open woods of the Montane region. (Not included in Table 2 because it is widespread in this region.)

7. SPECIAL FEATURES

7.1 Introduction

Nine particularly important sites in the study area are identified as special features (Fig. 9), and are rated as nationally, provincially or regionally significant. Nationally significant special features have nationally rare plant species (section 6) and/or vegetation types. Provincially significant special features have provincially rare (section 6) plant species and/or vegetation types. Regionally significant special features have "classic" examples of natural features, or have exceptional biological diversity.

7.2 Artemisia tridentata - Balsamorhiza sagittata Scrub

National Significance

The vegetation of this special feature is nationally, and likely internationally unique (section 4.7.2). As well, one nationally rare (Calochortus apiculatus) and three provcincially rare (Sedum stenopetalum, Castilleja hispida and Artemisia tridentata) plant species occur in this vegetation type (section 6).

7.3 Artemisia tridentata - Saxifraga bronchialis Scrub

National Significance

The vegetation of this special feature is nationally unique (section 4.7.2). As well, one nationally rare (Calochortus apiculatus) and three provincially rare (Sedum stenopetalum, Ceanothus velutinus and Artemisia tridentata) plant species occur in this vegetation type (section 6).

7.4 Artemisia tridentata - Rhamnus alnifolia Scrub

National Significance

The vegetation of this special feature is nationally, and likely internationally unique (section 4.7.2). As well, four provincially rare plant species (Sedum stenopetalum, Ribes inerme, Castilleja hispida and Artemisia tridentata) occur in this vegetation type (section 6).

7.5 Populus tremuloides Herb-rich Forest

National Significance

Nationally (Angelica dawsonii) and provincially (Habenaria saccata, Crataegus douglasii, Osmorhiza purpurea, Ribes inerme) rare plant species occur in these stands (section 6) and where undisturbed, the vegetation provides an excellent example of a type restricted to the Waterton-Crowsnest area (section 4.4.2).

7.6 Riparian Vegetation

National Significance

The rare species noted in section 7.5 also occur in Populus balsamifera forests in this unit (Special Feature 5a). Riparian Alnus - Salix thickets (Special Feature 5b) contain nationally rare (Angelica dawsonii) and provincially rare (Salix sitchensis, Saxifraga odontoloma, Tellima grandiflora, Ribes viscossimum, Orobanche uniflora) plant species (section 6).

7.7 Pinus albicaulis - Abies lasiocarpa Tall Forest

National Significance

The tall Pinus albicaulis are distinctive of the Waterton-Crowsnest area, and nationally (Carex geyeri) and provincially (Pyrola picta) species occur in the site mapped (section 6).

7.8 Moist Subalpine Creekside

National Significance

This small unit contains nationally (Epilobium glaberrimum) and provincially (Mertensia longiflora) rare species which do not occur elsewhere in the study area (section 6).

7.9 Subalpine Meadow Complex

National Significance

The extensive Subalpine/Montane meadows contain a patchwork of moist and dry microsites which were not thoroughly examined in this study. Cursory visits revealed a rich flora, including the nationally rare Xerophyllum tenax (section 6).

7.10 Larix lyallii Moist Forest

Regional Significance

"Classic" example of the cool, moist, upper Subalpine forests found on east slopes in the region, but absent on the drier and/or warmer slopes which cover the rest of our study area.

8. RECOMMENDATIONS

8.1 Boundary Changes

A number of nationally and provincially significant special features (section 7) lie outside the current boundaries of the candidate natural area. Boundary revisions mapped in figure are recommended in order to include these special features. Table 2 documents the occurrence of special features and rare plants (section 6) in the study area.

8.2 Mountain Pine Beetle

The Canadian Forestry Service and the Alberta Forest Service monitor pine beetle damage in the South Castle valley, but the candidate natural area warrants more detailed examination. Ground surveys should be conducted in late August or early September, as long as beetle populations are present in the region. New methods of beetle management are being developed, and periodic review of the literature and liaison with scientific authorities are recommended.

8.3 Recreation Use

Motorized recreation is becoming increasingly prevalent in the South Castle valley. The degree of damage to South Castle terraces should be monitored and buffer zones, interpretation facilities and fencing should be considered. Motorized recreation use in the *Artemisia tridentata* - *Balsamorhiza sagittata* community should be monitored.

Table 2

DISTRIBUTION OF SPECIAL FEATURES AND RARE PLANTS IN THE STUDY AREA

| LEGAL LOCATION | SPECIAL FEATURES (see section 7) | | | | | | | | | NATIONALLY RARE PLANTS (see section 6.2) | | | | | | | | | PROVINCIALLY RARE PLANTS (see section 6.3) | | | | | | | | |

8.4 Grazing

Cattle have severely influenced plant composition in the Artemisia tridentata - Rhamnus alnifolia habitat type. Exclosures should be set up to determine what vegetation changes would result from cattle exclusion. Two 20 m by 20 m plots were examined during the course of this study, and would serve as excellent sites for exclosure study. If these studies point to long-term changes which favor native species and the Artemisia tridentata population then a new grazing plan should be developed.

8.5 Fire

Complete fire suppression would have a positive effect on vegetation diversity in all but the Populus closed forest community. The extreme fire sensitivity of Artemisia tridentata requires special attention (section 5.4), and the presence of a natural fire break (ravine) west of the candidate natural area provides an additional argument for boundary extension in that direction.

8.6 Further Study

The heterogeneous Subalpine meadows (Fig. 9, section 7.9) should be visited in late May and late July in order to determine what species of rare plants are present, and assess their value to the natural areas system.

9. ANNOTATED LIST OF THE VASCULAR FLORA

Three hundred and nineteen species of vascular plants were found in the study area. This represents slightly over 18 per cent of the vascular flora of Alberta (Moss 1983) and is exceptional in such a small area. The species are listed below, with notes on their distribution and abundance (terms are defined in section 6.1).

LYCOPODIACEAE

Lycopodium annotinum L.
scarce in *Pinus contorta* forests at low elevations

SELAGINELLACEAE

Selaginella densa Rydb.
abundant and widespread in rockland, and *Artemisia tridentata* scrub

EQUISETACEAE

Equisetum arvense L.
common but restricted to disturbed areas

Equisetum hyemale L.
scarce along creeks in Montane zone

POLYPODIACEAE

Athyrium filix-femina (L.) Roth
scarce in thickets along creeks in lower Subalpine zone

Cryptogramma acrostichoides R.Br.
frequent and widespread in rockland and *Artemisia tridentata* scrub

Cystopteris fragilis (L.) Bernh.
frequent and widespread in rockland and *Artemisia tridentata* scrub

Polystichum lonchitis (L.) Roth
occasional in moist *Abies lasiocarpa* stands, seepage areas and stream banks, mainly in lower Subalpine zone

Woodsia oregana D.C. Eat.
occasional in rockland and *Artemisia tridentata* scrub

Woodsia scopulina D.C. Eat.
occasional in *Artemisia tridentata* scrub

CUPRESSACEAE

Juniperus communis L.
widespread and frequent in subxeric habitats of the Montane and Subalpine zones

Juniperus horizontalis Moench
widespread and frequent in subxeric habitats of the Montane and Subalpine zones
Juniperus scopulorum Sarg.
occasional in subxeric habitats of the Montane zone

PINACEAE
Abies lasiocarpa (Hook.) Nutt.
frequent and widespread in the Subalpine zone forests and coniferous scrub
Larix lyallii Parl.
occasional in upper Subalpine forests, and less often in coniferous scrub, dominates one north facing slope at southeast corner of area
Picea engelmannii Parry ex Engelm.
occasional in Subalpine forests
Picea glauca (Moench) Voss
occasional in Montane pine forests
Pinus albicaulis Engelm.
widespread in upper Subalpine coniferous forests
Pinus contorta Loudon
widespread in Montane and Subalpine forests
Pinus flexilis James
occasional in lower Subalpine and Montane coniferous scrub
Pseudotsuga menziesii (Mirb.) Franco
occasional in Montane pine and poplar forests

POACEAE (GRAMINEAE)
Agropyron albicans Scribn. & Smith
scarce in Artemisia tridentata scrub
Agropyron caninum (L.) Beauv. var majus [= A. trachycaulum (Link) Malte]
occasional in Artemisia tridentata scrub
Agropyron dasystachyum (Hook.) Scribn.
frequent in Artemisia tridentata scrub
Agropyron spicatum (Pursh) Scribn. & Smith
occasional in Artemisia tridentata scrub
Agropyron violaceum (Hornem.) Lange
occasional in upper Subalpine rockland
Agrostis scabra Willd.
occasional in disturbed Montane environments
Bromus carinatus Hook. & Arn.
occasional in Montane pine forest
Bromus ciliatus L.
scarce in subxeric open pine
Bromus inermis Leyss. ssp. pumpellianus (Scribn.) Wagnon
occasional in open Montane environments
Calamagrostis purpurascens R. Br.
occasional in dry Montane forests and Artemisia tridentata scrub
Calamagrostis rubescens Buckl.
widespread in Montane pine forest
Danthonia intermedia Vasey [= D. californica Boland]
occasional in dry Montane pine forests, Artemisia tridentata scrub, and rockland

Elymus glaucus Buckl.
shows signs of introgression with E. canadensis L.
occasional in Montane pine forest
Elymus innovatus Beal
scarce in Artemisia tridentata scrub
Festuca brachyphylla Schultes
occasional in Subalpine rockland
Festuca idahoensis Elmer
widespread in Artemisia tridentata scrub and lower Subalpine rockland
Festuca saximontana Rydb.
(sensu stricto, see Moss 1959)
scarce in dry Montane pine forest
Festuca scabrella Torr.
scarce in Artemisia tridentata scrub
Koeleria cristata (L.) Pers. [= K. macrantha (Ledeb.) J.A. Schultes]
widespread in Artemisia tridentata scrub and lower Subalpine/Montane rockland
Melica smithii (Porter) Vasey
scarce in moist Subalpine draws
Oryzopsis exigua Thurb.
frequent in lower Subalpine coniferous scrub and rockland
Phleum alpinum L. [= P. commutatum Gaudin]
occasional in upper Subalpine rockland
Phleum pratense L.
frequent in disturbed Montane environments
Poa alpina L.
occasional in Subalpine rockland
Poa canbyi (Scribn.) Piper
occasional in Artemisia tridentata scrub
Poa interior Rydb.
shows signs of introgression with P. nemoralis L. (sensu stricto)
occasional in rockland
Poa pratensis L.
occasional in Artemisia tridentata scrub, rockland and disturbed environments
Poa sandbergii Vasey
occasional in Artemisia tridentata scrub
Poa stenantha Trin.
scarce in lower Subalpine rockland
Sitanion hystrix (Nutt.) J.G. Smith
scarce in Artemisia tridentata scrub
Stipa occidentalis Thurb. [= S. columbiana Macoun, = S. nelsonii Scribn.]
frequent in Artemisia tridentata scrub
Trisetum canescens Buckl.
occasional in Montane pine forest
Trisetum spicatum (L.) Richt.
frequent in rockland

CYPERACEAE
Carex albonigra Mack.
scarce in rockland

Carex atrosquama Mack.
scarce in rockland
Carex concinnoides Mack.
widespread in Montane pine forest and Artemisia tridentata scrub
Carex geyeri Boott
occasional in open coniferous forests of Subalpine zone
Carex hoodii Boott
occasional in Artemisia tridentata scrub
Carex macloviana D'Urv.
frequent in Artemisia tridentata scrub
Carex microptera Mack.
shows signs of introgression with the preceding spp.
occasional in dry Montane pine woods
Carex obtusata Lilj.
frequent but inconspicuous in Artemisia tridentata scrub
Carex petasata Dewey
occasional in Artemisia tridentata scrub and open Subalpine coniferous forest
Carex phaeocephala Piper
occasional in rockland
Carex praticola Rydb.
scarce in Artemisia tridentata scrub
Carex raynoldsii Dewey
occasional in moist open aspen forest
Carex rossii Boott
frequent in Artemisia tridentata scrub
Carex rupestris All.
scarce in fell-fields
Carex xerantica Bailey
scarce in Artemisia tridentata scrub
Kobresia bellardii (All.) Degl. [= K. myosuroides (Vill.) Fiori & Paol.]
scarce in upper Subalpine rockland

JUNCACEAE
Juncus parryi Engelm.
scarce in rockland
Luzula multiflora (Retz.) Lej.
scarce along lower Subalpine creeks
Luzula parviflora (Ehrh.) Desv.
scarce in Subalpine coniferous woods
Luzula spicata (L.) DC.
scarce in upper Subalpine rockland
Luzula wahlenbergii Rupr. [= L. piperi (Cov.) M.E. Jones]
scarce in upper Subalpine rockland

LILIACEAE
Allium cernuum Roth
frequent in Artemisia tridentata scrub
Calochortus apiculatus Baker
frequent in Artemisia tridentata scrub, open Montane pine forest, and coniferous scrub
Clintonia uniflora (Schult.) Kunth
occasional in Montane pine forest

Disporum trachycarpum (S. Wats.) B. & H.
scarce in poplar forest
Erythronium grandiflorum Pursh
frequent in Montane pine and mixed Subalpine coniferous forest
Smilacina racemosa (L.) Desf.
frequent, occurs in poplar forest and willow-alder thickets
Smilacina stellata (L.) Desf.
occasional in *Artemisia tridentata* scrub
Stenanthium occidentale A. Gray
frequent in Subalpine coniferous forest
Veratrum eschscholtzii (R. & S.) A. Gray
occasional in moist draws and coniferous forests of lower Subalpine zone
Xerophyllum tenax (Pursh) Nutt.
scarce in moist Subalpine openings
Zygadenus venenosus S. Wats. [= *Z. gramineus* (Rydb.) Walsh]
frequent in *Artemisia tridentata* scrub

IRIDACEAE
Sysirinchium montanum Greene
occasional in *Artemisia tridentata* scrub and rockland

ORCHIDACEAE
Calypso bulbosa (L.) Oakes
frequent in Montane pine forests
Goodyera oblongifolia Raf.
occasional in Montane pine forest and Subalpine coniferous forests
Habenaria dilatata (Pursh) Hook.
scarce along Montane streams
Habenaria saccata Greene
scarce along Montane streams
Habenaria unalascensis (Spreng.) S. Wats
scarce in Montane pine forest

SALICACEAE
Populus balsamifera L.
frequent along creeks and occasional in rockland
Populus tremuloides Michx.
frequent in Montane deciduous forests, occasional in rockland
Salix sitchensis Sanson
frequent in willow-alder thickets
Salix vestita Pursh
scarce in upper Subalpine seepage in rocks

BETULACEAE
Alnus crispa (Ait.) Pursh
frequent in Montane pine woods and occasional along streams
Alnus tenuifolia Nutt.
frequent along streams

URTICACEAE
Urtica gracilis Ait. [= *U. dioica* L. ssp. *gracilis* (Ait.) Selander]
occasional along streams in Montane zone

SANTALACEAE

Comandra pallida (L.) Nutt. [= *C. umbellata* (L.) Nutt. var *pallida* (DC.) M.E. Jones]

frequent in *Artemisia tridentata* scrub

LORANTHACEAE

Arceuthobium americanum Nutt.

occasional on pine in Montane and Subalpine regions

POLYGONACEAE

Eriogonum androsaceum Benth.

occasional in fell-fields

Eriogonum ovalifolium Nutt.

occasional in fell-fields

Eriogonum umbellatum Torr. [= *E. subalpinum* Greene]

frequent in *Artemisia tridentata* scrub and lower Subalpine rockland

Polygonum aviculare L.

occasional in severely disturbed, dry, Montane habitats

Polygonum douglasii Greene

abundant in *Artemisia tridentata* scrub

PORTULACACEAE

Claytonia lanceolata Pursh

frequent in open areas moistened by spring melt

CARYOPHYLLACEAE

Arenaria capillaris Poir.

occasional in rockland

Arenaria lateriflora L. [= *Moehringia lateriflora* (L.) Fenzl.]

scarce in poplar forest and along streams

Arenaria nuttallii Pax [= *Minuartia nuttallii* (Pax) Briq.]

frequent on flaggey and channery colluvial slopes

Arenaria obtusiloba (Rydb.) Fern. [= *Minuartia obtusiloba* (Rydb.) House]

occasional on dry rockland, particularly fell-fields

Arenaria rubella (Wahl.) J.E. Smith [= *Minuartia rubella* (Wahl.) Graebn.]

occasional on dry rockland, occasionally fell-fields

Cerastium arvense L.

frequent in *Artemisia tridentata* scrub

Silene acaulis L.

occasional in upper Subalpine rockland

Silene drummondiana Hook. [= *Lychnis drummondiana* (Hook.) S. Wats.]

occasional in *Artemisia tridentata* scrub

Silene parryi (S. Wats.) C.L. Hitchc. & Maguire

scarce in *Artemisia tridentata* scrub and rockland

Stellaria longipes Goldie

frequent in *Artemisia tridentata* scrub

RANUNCULACEAE

Actaea rubra (Ait.) Willd.

occasional in deciduous forest and thickets, and in moist seeps

Anemone lithophila Rydb. [= A. drummondii S. Wats.]
occasional in upper Subalpine rockland
Anemone multifida Poir.
frequent in Artemisia tridentata scrub and pine forests
Anemone patens L.
occasional in Artemisia tridentata scrub
Aquilegia flavescens S. Wats.
occasional in seasonally mesic rockland and pine forest
Clematis occidentalis (Hornem.) DC. [= C. verticellaris DC.]
occasional in coniferous forests of the Montane and Subalpine zones
Delphinium bicolor Nutt.
occasional in open Montane pine woods and Artemisia tridentata scrub
Ranunculus cymbalaria Pursh
scarce in moist Montane openings
Ranunculus glaberrimus Hook.
scarce in seasonally moist Subalpine creek edges
Ranunculus uncinatus D. Don
occasional in poplar forest
Thalictrum occidentale A. Gray
widespread in Montane and Subalpine forests

BERBERIDACEAE
Berberis repens Lindl. [= Mahonia repens (Lindl. G. Don]
frequent in dry, open woods

BRASSICACEAE (CRUCIFERAE)
Arabis divaricarpa A. Nels.
occasional in open Montane pine forest
Arabis drummondii A. Gray
occasional in rockland
Arabis hirsuta (L.) Scop.
occasional in Artemisia tridentata scrub
Arabis holboellii Hornem.
widespread in open, dry Montane areas (particularly Artemisia tridentata scrub)
Arabis lemmonii S. Wats.
scarce in upper Subalpine rockland
Arabis lyallii S. Wats.
scarce in upper Subalpine rockland
Capsella bursa-pastoris (L.) Medic.
frequent in severely disturbed Montane openings
Draba albertina Greene
occasional in upper Subalpine rockland
Draba aurea Vahl
widespread in rockland and Artemisia tridentata scrub
Draba cana Rydb. [= D. lanceolata Royle]
occasional in rockland
Draba crassifolia R. Grah.
occasional in rockland
Draba densifolia Nutt. ex T. & G.
scarce in upper Subalpine rockland

Draba incerta Payson
scarce in rockland
Draba nemorosa L.
scarce in rockland
Draba paysonii Macbr.
occasional in rockland
Draba verna L.
scarce in disturbed Montane areas
Erysimum cheiranthoides L.
widespread in Artemisia tridentata scrub
Erysimum inconspicuum (S. Wats.) MacM.
occasional in Artemisia tridentata scrub
Physaria didymocrpa (Hook.) A. Gray
occasional in rockland
Smelowskia calycina (Stephan.) C.A. Meyer
frequent in upper Subalpine rockland

CRASSULACEAE
Sedum lanceolatum Torr. [= S. stenopetalum Pursh of Moss 1959]
frequent in Artemisia tridentata scrub and lower Subalpine rockland
Sedum rosea (L.) Scop. [= Rhodiola rosea L.]
[= Tolmachevia integrifolia (Raf.) Love & Love]
scarce in rocky seeps
Sedum stenopetalum Pursh [= S. douglasii Hook. of Moss 1959]
frequent in Artemisia tridentata scrub and rockland

SAXIFRAGACEAE
Heuchera cylindrica Dougl. ex Hook.
frequent in Artemisia tridentata scrub and rockland
Mitella nuda L.
scarce in coniferous forest
Mitella pentandra Hook.
scarce in willow-alder thickets
Parnassia fimbriata Konig
scarce in creekside poplar forest and willow-alder thickets
Saxifraga bronchialis L.
widespread in rockland
Saxifraga lyallii Engler
scarce in rocky seeps
Saxifraga mertensiana Bong.
scarce in rocky seeps
Saxifraga odontoloma Piper [= S. arguta D. Don]
scarce in rocky seeps
Tellima grandiflora (Pursh) Dougl.
scarce in rocky seeps

GROSSULARIACEAE
Ribes inerme Rydb.
occasional in Artemisia tridentata - Rhamnus alnifolia scrub and along creeks
Ribes lacustre (Pers.) Poir.
occasional in seasonally wet rockland

Ribes oxyacanthoides L.
scarce in Artemisia tridentata - Rhamnus alnifolia scrub
Ribes viscosissimum Pursh
occasional in cool coniferous woods and streamsides

ROSACEAE
Amelanchier alnifolia Nutt.
widespread in rockland and Artemisia tridentata scrub, as well as poplar forest
Crataegus douglasii Lindl.
occasional in poplar forest
Dryas octopetala L.
scarce in fell-fields
Fragaria virginiana Duchesne
frequent in rockland, Artemisia tridentata scrub and forests
Geum macrophylum Willd.
occasional in Artemisia tridentata - Rhamnus alnifolia scrub and poplar forest
Geum triflorum Pursh
frequent in Artemisia tridentata scrub, occasional in rockland
Potentilla diversifolia Lehm.
occasional in rockland
Potentilla fruticosa L.
occasional in rockland
Potentilla glandulosa Lindl.
frequent in Artemisia tridentata scrub and rockland
Potentilla gracilis Dougl. ex Hook
frequent in Artemisia tridentata scrub and rockland
Potentilla nivea L.
scarce in fell-fields
Potentilla norvegica L.
occasional along road
Potentilla ovina Macoun
scarce in rockland
Potentilla pensylvanica L.
scarce in rockland
Prunus virginiana L.
occasional in rockland and Artemisia tridentata scrub
Rosa woodsii Lindl.
frequent in Artemisia tridentata scrub and rockland
Rubus parviflorus Nutt.
frequent in coniferous and deciduous forests
Rubus pubescens Raf.
occasional in poplar forest
Rubus strigosus Michx. [= R. idaeus L.]
occasional in rockland
Sibbaldia procumbens L.
scarce in fell-fields
Sorbus scopulina Greene
occasional in seeps and moist Subalpine forest
Spiraea lucida Dougl. [= S. betulifolia Pallas]
frequent in Montane pine and aspen forest, occasional in Subalpine coniferous forest

FABACEAE (LEGUMINOSAE)

Astragalus americanus (Hook.) M.E. Jones
occasional in poplar forest and along streams

Astragalus bourgovii A. Gray
occasional along streams

Astragalus vexilliflexus Sheldon
frequent on windswept ridges

Glycyrriza lepidota (Nutt.) Pursh
occasional along streams

Hedysarum alpinum L.
scarce along streams

Hedysarum sulphurescens Rydb.
occasional in *Artemisia tridentata* scrub

Lathyrus ochroleucus Hook.
occasional in poplar forest

Lupinus sericeus Pursh
widespread in *Artemisia tridentata* scrub

Medicago lupulina L.
scarce along road

Oxytropis cusickii Greenm.
frequent in *Artemisia tridentata* scrub

Oxytropis splendens Dougl. ex Hook.
occasional in *Artemisia tridentata* scrub

Trifolium repens L.
frequent along road

Vicia americana Muhl.
occasional in Montane pine and poplar forests

GERANIACEAE

Geranium richardsonii Fisch. & Trautv.
scarce in poplar forest

Geranium viscossisimum Fisch. & Mey.
frequent in poplar forest

LINACEAE

Linum lewisii Pursh [= *Linum perenne* L. var *lewisii* (Pursh) Hult.]
frequent in *Artemisia tridentata* scrub and rockland

ACERACEAE

Acer glabrum Torr. [= *A. douglasii* Hook.]
frequent in rockland and moist openings in Subalpine

RHAMNACEAE

Ceanothus velutinus Dougl. ex Hook.
frequent and widespread, in rockland, poplar forest, pine forest, *Artemisia tridentata* scrub

Rhamnus alnifolia L'Her.
frequent in *Artemisia tridentata* scrub on river terraces

VIOLACEAE

Viola adunca J.E. Smith
frequent in pine forests, *Artemisia tridentata* scrub and rockland

Viola canadensis L. [= *V. rugulosa* Greene]
frequent in poplar forest

Viola glabella Nutt.
occasional in moist woods
Viola orbiculata Geyer ex Hook.
frequent in Subalpine coniferous forest

ELEAGNACEAE
Shepherdia canadensis (L.) Nutt
frequent in Montane pine forest and Artemisia tridentata scrub

ONAGRACEAE
Circaea alpina L.
scarce in willow-alder thickets
Epilobium angustifolium L.
occasional in pine and poplar forests
Epilobium glaberrimum Barbey
scarce along seasonally wet stream courses
Epilobium hornemannii Reichenb.
scarce along seasonally wet stream courses
Epilobium lactiflorum Hausskn.
scarce along seasonally wet stream courses

APIACEAE (UMBELLIFERAE)
Angelica arguta Nutt.
scarce in poplar forests along creeks
Angelica dawsonii S. Wats.
occasional in moist forests from Montane to Subalpine zone
Heracleum lanatum Michx.
frequent along creeks and in moist draws
Lomatium dissectum (Nutt.) Mathias & Constance
occasional in dry Subalpine coniferous forests
Lomatium macrocarpum (Hook. & Arn.) Coult. & Rose
occasional in Artemisia tridentata scrub
Lomatium triternatum (Pursh) Coult. & Rose
frequent in Artemisia tridentata scrub
Osmorhiza chilensis Hook. & Arn. (s.s.)
occasional in poplar woods
Osmorhiza depauperata Philippi
occasional along streams
Osmorhiza occidentalis (Nutt.) Torr.
frequent in Montane pine and poplar woods
Osmorhiza purpurea (Coult. & Rose) Suksd.
occasional along streams

CORNACEAE
Cornus canadensis L.
occasional in Montane pine and poplar forests
Cornus stolonifera Michx.
frequent in willow-alder thickets

PYROLACEAE
Chimaphila umbellata (L.) Bart.
frequent in pine forests

Pyrola asarifolia Michx.
occasional in pine forests
Pyrola picta
scarce in Subalpine pine forests
Pyrola secunda L. [= Orthilia secunda (L.) House]
occasional in Montane pine and poplar forests
Pyrola virens Schweig. [= P. chlorantha Sw.]
frequent in pine forests

ERICACEAE
Arctostaphylos uva-ursi (L.) Spreng.
frequent on rockland and in Artemisia tridentata scrub
Ledum groenlandicum Oeder
scarce in poplar forest
Menziesia ferruginea J.E. Smith
occasional in Subalpine coniferous forest
Vaccinium caespitosum Michx.
widespread in Montane pine forest
Vaccinium membranaceum Dougl. ex Hook.
widespread in coniferous forests
Vaccinium myrtillus L.
widespread in coniferous forests, often intergrading with the previous species, and the next one
Vaccinium scoparium Leiberg
widespread in coniferous forests

PRIMULACEAE
Dodecatheon conjugens Greene
frequent in Artemisia tridentata scrub and along seasonal creeks

GENTIANACEAE
Gentianella amarella (L.) Borner
occasional in rockland and Artemisia tridentata scrub

APOCYNACEAE
Apocynum androsaemifolium L.
occasional in rockland

POLEMONIACEAE
Collomia linearis Nutt.
scarce, and easily overlooked, in Artemisia tridentata scrub
Polemonium pulcherrimum Hook.
widespread in seasonally moist areas

HYDROPHYLLACEAE
Phacelia hastata Dougl. ex Lehm.
frequent in rockland
Phacelia sericea (Graham) A. Gray
frequent in Artemisia tridentata scrub and seasonally moist areas

BORAGINACEAE
Hackelia floribunda (Lehm.) I.M. Johnston
frequent in Montane poplar and pine

Hackelia jessicae (McGreg.) Brand
frequent in Artemisia tridentata scrub and Montane pine forests
Lithospermum ruderale Lehm.
frequent in Artemisia tridentata scrub
Mertensia longiflora Greene
scarce along seasonally moist Subalpine streams
Mertensia paniculata (Ait.) G. Don
frequent in willow-alder thickets and rich poplar woods
Myosotis alpestris Schmidt
occasional in upper Subalpine rockland

LAMNIACEAE (LABIATAE)
Monarda fistulosa L.
widespread in Artemisia tridentata scrub and Montane pine

SCROPHULARIACEAE
Castilleja hispida Benth.
widespread in Montane pine and Artemisia tridentata scrub
Castilleja miniata Dougl. ex Hook.
frequent in moist poplar thickets
Collinsia parviflora Lindl.
widespread, but easily overlooked, in Artemisia tridentata scrub
Pedicularis bracteosa Benth.
frequent in Subalpine coniferous forests and moist draws
Penstemon albertinus Greene
scarce in rockland
Penstemon confertus Dougl.
widespread in Artemisia tridentata scrub and rockland
Penstemon ellipticus
scarce in rockland
Penstemon eriantherus Pursh
scarce in rockland
Penstemon fruticosus (Pursh) Greene
scarce in rockland
Penstemon lyallii A. Gray
scarce in rockland
Rhinanthus minor L. [= Rhinanthus crista-galli L.]
scarce in Artemisia tridentata scrub
Veronica alpina L.
scarce in fell-fields

OROBANCHACEAE
Orobanche fasiculata Nutt.
scarce in Artemisia tridentata scrub
Orobanche uniflora L.
scarce in willow-alder thickets

RUBIACEAE
Galium boreale L.
widespread in pine and poplar forests, Artemesia tridentata scrub and rockland
Galium triflorum Michx.
occasional in poplar forest and willow-alder scrub

CAPRIFOLIACEAE

Linnaea borealis L.
occasional in pine forest

Lonicera involucrata (Richards.) Banks
occasional in moist Subalpine draws and wilow-alder thickets

Lonicera utahensis S. Wats.
occasional in pine forest

Sambucus melanocarpa A. Gray [= *S. racemosa* L. var *melanocarpa* (Gray) McMinn]
frequent in moist Subalpine draws

Symphoricarpos albus (L.) Blake
widespread in Montane pine and poplar forest and *Artemisia tridentata* scrub.

Viburnum edule (Michx.) Raf.
occasional in poplar forests and along streams

VALERIANACEAE

Valeriana septentrionalis
scarce in poplar forests

Valeriana sitchensis Bong.
occasional in moist Subalpine coniferous woods, willow-alder thickets, and wet draws

CAMPANULACEAE

Campanula rotundifolia L.
widespread in *Artemisia tridentata* scrub and rockland

ASTERACEAE (COMPOSITAE)

Achillaea millefolium L.
occasional in Montane pine and aspen forests, *Artemisia tridentata* scrub, and rockland

Agoseris aurantiaca (Hook.) Greene
scarce in upper Subalpine rockland

Agoseris glauca (Pursh) Raf.
occasional in *Artemisia tridentata* scrub

Anaphalis margaritacea (L.) Benth. & Hook.
occasional along streams and in disturbed areas

Antennaria anaphaloides Rydb.
occasional in or near moist poplar thickets

Antennaria aprica Greene.
scarce in *Artemisia tridentata* scrub

Antennaria neglecta Greene
occasional in dry coniferous forests

Antennaria racemosa Hook.
occasional in moist, cool coniferous forests

Antennaria rosea Greene
occasional in *Artemisia tridentata* scrub

Antennaria umbrinella Rydb.
occasional in *Artemisia tridentata* scrub

Arnica cordifolia Hook.
frequent in coniferous forest

Arnica gracilis Rydb.
scarce in dry Subalpine coniferous forest

Arnica latifolia Bong.
occasional in Montane pine woods
Artemisia campestris L.
occasional in rockland and Artemisia tridentata scrub
Artemisia michauxiana Bess.
scarce in rockland
Artemisia tridentata Nutt.
widespread in Artemisia tridentata scrub
Aster ciliolatus Lindl.
frequent in pine woods and Artemisia tridentata scrub
Aster conspicuus Lindl.
frequent in Artemisia tridentata scrub
Aster laevis L.
occasional in Artemisia tridentata scrub
Aster subspicatus Nees. [= A. foliaceus Lindl.]
occasional in poplar forests
Chrysopsis villosa (Pursh) Nutt. [= Heterotheca villosa (Pursh) Shinners]
frequent in rockland and Artemisia tridentata scrub
Erigeron compositus Pursh
frequent in dry open areas from Montane to upper Subalpine
Erigeron glabellus Nutt.
occasional in Montane pine woods
Erigeron peregrinus (Pursh) Greene
occasional in open, moist, Subalpine areas
Erigeron speciosus (Lindl.) DC.
occasional in Montane pine woods
Gaillardia aristata Pursh
frequent in Artemisia tridentata scrub
Hieracium albiflorum Hook.
occasional in dry Montane pine woods
Hieracium canadense Michx. (s.s.) [= H. umbellatum L. in Moss (1983)]
scarce in dry Montane pine woods
Hieracium scabriusculum Schwein (s.s.) [= H. umbellatum L. in Moss (1983)]
scarce in moist poplar woods along creek
Matricaria matricarioides (Less.) Porter
frequent in dry, severely disturbed areas
Senecio canus Hook.
frequent in rockland and Artemisia tridentata scrub
Senecio integerrimus Nutt.
occasional in moist poplar woods
Senecio megacephalus Nutt.
occasional in upper Subalpine rockland
Senecio streptanthifolius Greene
scarce in open pine woods
Senecio triangularis Hook.
occasional in moist woods and meadows from upper Subalpine to Montane zone
Solidago gigantea Ait.
scarce in moist poplar woods
Solidago missouriensis Nutt.
occasional in dry pine woods and Artemisia tridentata scrub

Solidago multiradiata Ait.
occasional in rockland
Townsendia hookeri Beaman
scarce in Artemisia tridentata scrub
Tragopogon dubius Scop.
scarce along roads

10. ANNOTATED LISTS OF THE FAUNA

10.1 Introduction

Thirty eight bird species and 11 mammal species were found in the study area. High winds often drowned bird calls, and the list is far from complete. The mammal list is probably also incomplete, for example no sign or sightings of Black or Grizzly Bear were noted but they would be expected to occur in the area*. Some bird and mammal species could be considered characteristic of southwest Alberta (e.g., Calliope Hummingbird, Lazuli Bunting, and perhaps the Yellow Pine Chipmunk), however none could be considered rare or endangered in Alberta.

10.2 Birds

Northern Goshawk (Accipiter gentilis) - uncommon, at low elevations near Artemisia tridentata scrub

Sharp-shinned Hawk (Accipiter striatus) - uncommon, at low elevations near Artemisia tridentata scrub

Golden Eagle (Aquila chrysaetos) - uncommon, soaring over open slopes, particularly rockland

American Kestrel (Falco sparverius) - uncommon, near open areas

Blue Grouse (Dendragapus obscurus) - common in scrub and rockland

Calliope Hummingbird (Stellula calliope) - uncommon in open scrub

Rufous Hummingbird (Selasphorus rufus) - uncommon in open scrub and rockland

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* Upon subsequent visits to this site by the Natural Areas Program staff, Black Bears were consistently seen within the candidate Natural Area.

Common Flicker (Colaptes auratus) - uncommon in Populus forests

Hairy Woodpecker (Picoides villosus) - uncommon in open coniferous forests and rockland

Alder Flycatcher (Empidonax alnorum) - uncommon in Populus thickets

Least Flycatcher (Empidonax minimus) - uncommon in Populus forests and thickets

Tree Swallow (Tachycineta bicolor) - uncommon at edge of Populus forests

Clark's Nutcracker (Nucifraga columbiana) - common in rockland, uncommon in Abies lasiocarpa - Pinus and Pinus contorta forests

Common Raven (Corvus corax) - uncommon, habitat preferences unclear

American Crow (Corvus brachyrhynchos) - common in rockland

Black-capped Chickadee (Parus atricapillus) - common in Pinus contorta, Abies lasiocarpa - Pinus, and rockland

Mountain Chickadee (Parus gambeli) - common in Pinus contorta forests

Boreal Chickadee (Parus hudsonicus) - uncommon in open Pinus contorta and Abies lasiocarpa - Pinus forests

Red-breasted Nuthatch (Sitta canadensis) - uncommon in coniferous forests

American Robin (Turdus migratorius) - common in coniferous forests

Varied Thrush (Ixoreus naevius) - common in coniferous forests

Hermit Thrush (Catharus guttatus) - uncommon in moist coniferous forests

Mountain Bluebird (Sialia currucoides) - uncommon in open scrub

Townsend's Solitaire (Myadestes townsendi) - common in open coniferous forests

Golden-crowned Kinglet (Regulus satrapa) - common in coniferous forests

Ruby-crowned Kinglet (Regulus calendula) - uncommon in coniferous forests

Warbling Vireo (Vireo gilvus) - uncommon in Populus forests and thickets

Yellow-rumped Warbler (Dendroica coronata) - common in coniferous forests

Townsend's Warbler (Dendroica townsendi) - uncommon in coniferous forests

Brewer's Blackbird (Euphagus cyanocephalus) - uncommon in open scrub at low elevations

Western Tanager (Piranga ludoviciana) - uncommon in low elevation coniferous forests .

Lazuli Bunting (Passerina amoena) - uncommon in Populus thickets, open scrub and rockland

Pine Siskin (Carduelis pinus) - common in coniferous forests

Dark-eyed Junco (Junco hyemalis) - common in coniferous forests

Chipping Sparrow (Spizella passerina) - common in coniferous forests

Brewer's Sparrow (Spizella breweri) - uncommon in scrub and rockland

White-crowned Sparrow (Zonotrichia leucophrys) - common in Populus thickets, open scrub and rockland

10.3 Mammals

Least Chipmunk (Eutamias minimus) - uncommon in rockland and open coniferous forests

Yellow Pine Chipmunk (Eutamias amoenus) - uncommon in coniferous forests

Columbian Ground Squirrel (Spermophilus columbianus) - common in open scrub

Golden-mantled Ground Squirrel (Spermophilus lateralis) - common in rockland and open coniferous forests

Red Squirrel (Tamiasciurus hudsonicus) - common in coniferous forests

Coyote (Canis latrans) - uncommon in open scrub

Mule Deer (Odocoileus hemionus) - common in open scrub

Whitetail Deer (Odocoileus virginianus) - uncommon in low elevation Populus and coniferous forests and open scrub

Moose (Alces alces) - common in open scrub and rockland

Elk (Cervus elaphus) - common in open scrub and rockland

Bighorn Sheep (Ovis canadensis) - uncommon in rockland

APPENDIX I
VEGETATION DATA SHEETS

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

PINUS CONTORTA

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 001	SCSL 006	SCSL 010	SCSL 011	SCSL 012	SCSL 013	SCSL 017	SCSL 018	SCSL 023
NUMBER OF SPECIES PER PLOT	25.2		33	40	26	18	12	28	22	33	15
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C	%C	%C	%C
A1 LAYER											
1 Pinus contorta	88.9	31.7	15	30		50	55	50	50	15	20
2 Abies lasiocarpa	11.1	0.2	2								
3 Pseudotsuga menziesii	11.1	0.1								1	
B1 LAYER											
Pinus contorta	33.3	2.4	1		20	1					
Abies lasiocarpa	22.2	0.2	1			1					
4 Picea glauca	11.1	0.1		1							
5 Pinus flexilis	11.1	0.1				1					
Pseudotsuga menziesii	11.1	0.1		1							
B2 LAYER											
6 Spiraea betulifolia(lucida	77.8	4.4	1	10	1	15	3		7	3	
7 Juniperus communis	77.8	1.8	10	1	1	1		1	1	1	
8 Amelanchier alnifolia	66.7	3.6	1	1	1			1		20	8
9 Shepherdia canadensis	66.7	1.3	2	1	1			1	6	1	
10 Rubus paracaulis	55.6	1.7		10		1		1	2	1	
11 Vaccinium membranaceum	44.4	6.1	1	8	1	45					
12 Symphoricarpos albus	44.4	1.4	1	10			1		1		
13 Berberis repens	44.4	0.9		5				1	1	1	
Pinus contorta	44.4	0.9	1		5	1			1		
14 Acer glabrum	44.4	0.7	1						2	1	2
Abies lasiocarpa	33.3	0.3	1		1	1					
15 Alnus crispa	22.2	1.2		1		10					
Picea glauca	22.2	0.2						1	1		
Pseudotsuga menziesii	22.2	0.2						1	1		
16 Ribes lacustre	22.2	0.2			1					1	
17 Crataegus douglasii	11.1	0.1					1				
18 Juniperus horizontalis	11.1	0.1						1			
19 Lonicera utahensis	11.1	0.1		1							
20 Penstemon fruticosus	11.1	0.1			1						
Pinus flexilis	11.1	0.1				1					
21 Populus tremuloides	11.1	0.1								1	
22 Potentilla fruticosa	11.1	0.1						1			
23 Ribes viscosissimum	11.1	0.1	1								
24 Rosa acicularis	11.1	0.1						1			
25 Rosa woodsii	11.1	0.1		1							
26 Salix sp.	11.1	0.1								1	
C LAYER											
27 Arnica cordifolia	88.9	8.6	3	1		1	65	1	1	2	3
28 Fragaria virginiana	66.7	1.7		1		1	4	1		5	3
29 Vaccinium caespitosum	55.6	14.2		8				10	40	45	25
30 Epilobium angustifolium	55.6	0.6	1	1				1	1	1	
31 Arctostaphylos uva-ursi	44.4	2.3	3		2					1	15
32 Chimaphila umbellata	44.4	0.8		1		1	1	4			
33 Castilleja hispida	44.4	0.7				1		1	1	3	
34 Galium boreale	44.4	0.4		1			1	1		1	
35 Heuchera cylindrica	44.4	0.4	1		1				1		1
36 Thalictrum occidentale	33.3	1.8					15	1		.5	

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

PINUS CONTORTA

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 001	SCSL 006	SCSL 010	SCSL 011	SCSL 012	SCSL 013	SCSL 017	SCSL 018	SCSL 023
NUMBER OF SPECIES PER PLOT	25.2		33	40	26	18	12	28	22	33	15
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C	%C	%C	%C
37 Linnaea borealis	33.3	0.7		4				1	1		
38 Lathyrus ochroleucus	33.3	0.4		1				1		2	
39 Achillea millefolium	33.3	0.3		1	1					.5	
40 Campanula rotundifolia	33.3	0.3		1				1	1		
41 Clematis occidentalis(vert	33.3	0.3		1						1	1
42 Lomatium triternatum	33.3	0.3		1						1	1
43 Pyrola chlorantha(virens)	33.3	0.3		1				1	1		
Spiraea betulifolia(lucida	22.2	5.6						50		.5	
44 Saxifraga bronchialis	22.2	0.6	4		1						
45 Cryptogramma acrostichoide	22.2	0.2	1		1						
46 Erythronium grandiflorum	22.2	0.2		1						.5	
47 Sedum lanceolatum	22.2	0.2			1					.5	
48 Taraxacum officinale	22.2	0.2		1			1				
49 Viola adunca	22.2	0.2						1	1		
50 Viola orbiculata	22.2	0.2		1				1			
Berberis repens	11.1	0.6									5
51 Ceanothus velutinus	11.1	0.4									4
52 Vaccinium scoparium	11.1	0.4		4							
53 Aquilegia flavescens	11.1	0.2								2	
54 Arabis holboellii	11.1	0.1								.5	
55 Arnica gracilis	11.1	0.1	1								
56 Artemisia tridentata	11.1	0.1								1	
57 Aster ciliolatus	11.1	0.1		1							
58 Aster conspicuus	11.1	0.1		1							
59 Castilleja miniata	11.1	0.1		1							
60 Erigeron sp.	11.1	0.1			1						
61 Erigeron speciosus(subtrin	11.1	0.1		1							
62 Goodyera oblongifolia	11.1	0.1					1				
63 Hedysarum sulphurescens	11.1	0.1		1							
64 Hieracium albiflorum	11.1	0.1		1							
Juniperus communis	11.1	0.1							1		
Lonicera utahensis	11.1	0.1		1							
65 Lupinus sericeus	11.1	0.1						1			
66 Moehringia lateriflora(Are	11.1	0.1								1	
67 Orthilia secunda(Pyrola se	11.1	0.1				1					
68 Penstemon albertinus(viren	11.1	0.1	1								
69 Penstemon confertus	11.1	0.1	1								
70 Potentilla glandulosa	11.1	0.1			1						
71 Potentilla gracilis	11.1	0.1	1								
Rosa woodsii	11.1	0.1		1							
Rubus paracaulis	11.1	0.1								.5	
72 Selaginella densa	11.1	0.1			1						
73 Solidago missouriensis	11.1	0.1	1								
74 Stenanthium occidentale	11.1	0.1									1
Symphoricarpos albus	11.1	0.1							1		
75 Woodsia scopulina	11.1	0.1	1								
D LAYER											
76 Calamagrostis rubescens	44.4	1.7		8			1	1		5	
77 Oryzopsis exigua	22.2	0.3			1	2					
78 Trisetum spicatum	11.1	0.6	5								
79 Agropyron trachycaulum v.	11.1	0.2	2								
80 Calamagrostis purpurascens	11.1	0.1			1						
81 Carex concinna	11.1	0.1									1
82 Carex deflexa	11.1	0.1	1								
83 Carex phaeocephala	11.1	0.1			1						
EX LAYER											
84 Polytrichum commune	11.1	1.1									10
EL LAYER											
85 Umbilicaria sp.	22.2	3.3	5		25						
86 Lecidia sp.	22.2	1.1	5		5						
87 Rhizocarpon sp.	11.1	1.7	15								
88 Rhizocarpon geographicum	11.1	1.3			12						
89 Lecanora sp.	11.1	0.6	5								
90 Lepraria sp.	11.1	0.6			5						

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

ABIES-PINUS

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 003	SCSL 015	SCSL 022	SCSL 026	SCSL 027	SCSL 004
NUMBER OF SPECIES PER PLOT	20.0		14	17	24	13	17	35
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C
A1 LAYER								
1 Abies lasiocarpa	66.7	8.3	30		5		5	10
2 Pinus albicaulis	50.0	15.8			40	30	25	
3 Picea engelmannii	50.0	1.8	5		5	1		
4 Pinus contorta	33.3	6.7			15			25
A2 LAYER								
Abies lasiocarpa	33.3	1.0	5					1
Pinus contorta	16.7	0.2						1
B1 LAYER								
Abies lasiocarpa	33.3	2.8	5	12				
Pinus albicaulis	16.7	3.3		20				
Picea engelmannii	16.7	0.5		3				
B2 LAYER								
5 Juniperus communis	66.7	2.0		1		3	5	3
Abies lasiocarpa	50.0	4.8	1	8				20
6 Vaccinium membranaceum	50.0	2.3	2	2	10			
7 Berberis repens	33.3	0.5			1			2
8 Spiraea betulifolia(lucida	33.3	0.5					2	1
9 Ribes lacustre	33.3	0.3			1		1	
10 Menziesia ferruginea(glabe	16.7	5.8	35					
11 Rubus paracaulis	16.7	1.3						8
12 Shepherdia canadensis	16.7	0.7						4
13 Alnus crispa	16.7	0.5			3			
14 Potentilla fruticosa	16.7	0.5				3		
15 Acer glabrum	16.7	0.3						2
16 Lonicera utahensis	16.7	0.3			2			
Picea engelmannii	16.7	0.3		2				
17 Ribes viscosissimum	16.7	0.3			2			
18 Rosa acicularis	16.7	0.2					1	
19 Sambucus racemosa v. mel.(	16.7	0.2			1			
20 Symphoricarpos albus	16.7	0.2						1
C LAYER								
21 Arnica cordifolia	66.7	3.3	1	1	10			8
22 Orthilia secunda(Pyrola se	50.0	0.5	1	1	1			
23 Saxifraga bronchialis	50.0	0.4		1		.5	1	
24 Thalictrum occidentale	33.3	2.8			10			7
25 Chimaphila umbellata	33.3	1.8		1	10			
26 Osmorhiza chilensis	33.3	0.7			2			2
27 Epilobium angustifolium	33.3	0.5					1	2
28 Viola orbiculata	33.3	0.5			1			2
29 Goodyera oblongifolia	33.3	0.3			1			1
30 Heuchera cylindrica	33.3	0.3		1			1	
31 Smelowskia calycina	33.3	0.3		1		1		
32 Arctostaphylos uva-ursi	16.7	3.3				20		
Abies lasiocarpa	16.7	1.7						10
33 Valeriana sitchensis	16.7	1.3						8
34 Antennaria racemosa	16.7	1.2						7
35 Aster sp.	16.7	0.8						5

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

ABIES-PINUS

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 003	SCSL 015	SCSL 022	SCSL 026	SCSL 027	SCSL 004
NUMBER OF SPECIES PER PLOT	20.0		14	17	24	13	17	35
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C
Spiraea betulifolia(lucida	16.7	0.8			5			
36 Fragaria virginiana	16.7	0.7						4
37 Smilacina racemosa	16.7	0.7						4
38 Pedicularis bracteosa	16.7	0.5						3
39 Veratrum eschscholtzii	16.7	0.5			3			
40 Achillea millefolium	16.7	0.2					1	
41 Actaea rubra	16.7	0.2						1
42 Antennaria parvifolia(niti	16.7	0.2		1				
43 Aquilegia flavescens	16.7	0.2						1
44 Arenaria capillaris	16.7	0.2		1				
45 Aster ciliolatus	16.7	0.2			1			
46 Aster conspicuus	16.7	0.2						1
47 Astragalus americanus(frig	16.7	0.2						1
48 Calypso bulbosa	16.7	0.2			1			
49 Castilleja miniata	16.7	0.2						1
50 Clematis occidentalis(vert	16.7	0.2						1
51 Eriogonum umbellatum v. su	16.7	0.2					1	
52 Galium boreale	16.7	0.2					1	
53 Heracleum lanatum	16.7	0.2			1			
54 Lycopodium annotinum	16.7	0.2	1					
55 Maianthemum canadense	16.7	0.2						1
56 Penstemon confertus	16.7	0.2					1	
57 Penstemon fruticosus	16.7	0.2		1				
58 Pyrola chlorantha(virens)	16.7	0.2						1
59 Sedum stenopetalum	16.7	0.2					1	
60 Silene acaulis	16.7	0.2				1		
61 Solidago multiradiata	16.7	0.2					1	
62 Stenanthium occidentale	16.7	0.2						1
63 Streptopus amplexifolius	16.7	0.2	1					
64 Potentilla diversifolia	16.7	0.1				.5		
D LAYER								
65 Carex sp.	16.7	0.7						4
66 Agrostis thurberiana	16.7	0.2		1				
67 Carex geyeri	16.7	0.2			1			
68 Festuca idahoensis	16.7	0.2					1	
69 Oryzopsis exigua	16.7	0.2					1	
EX LAYER								
70 Dicranella sp.	16.7	0.2	1					
71 Mnium sp.	16.7	0.2	1					
72 Pleurozium schreberi	16.7	0.2	1					
EL LAYER								
73 Rhizocarpum sp.	16.7	1.7				10		
74 Lecanora sp.	16.7	1.2				7		
75 Leidia sp	16.7	1.2				7		
76 Umbilicaria sp.	16.7	0.2				1		

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

POPULUS

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 009	SCSL 014	SCSL 020	SCSL 021	SCSL 025
NUMBER OF SPECIES PER PLOT	27.6		25	48	15	26	24
SPECIES	%P	MC	%C	%C	%C	%C	%C
A1 LAYER							
1 Populus tremuloides	40.0	35.0	90			85	
2 Pseudotsuga menziesii	20.0	0.2			1		
A2 LAYER							
Populus tremuloides	40.0	0.9	4		.5		
Pseudotsuga menziesii	20.0	0.2	1				
B1 LAYER							
Populus tremuloides	100.0	29.2	1	2	75	3	65
3 Crataegus douglasii	40.0	0.6	1			2	
4 Acer glabrum	20.0	0.4		2			
5 Abies lasiocarpa	20.0	0.2		1			
6 Pinus albicaulis	20.0	0.2		1			
7 Pinus contorta	20.0	0.2		1			
8 Populus balsamifera ssp. t	20.0	0.2		1			
9 Salix sp.	20.0	0.2		1			
B2 LAYER							
10 Symphoricarpos albus	100.0	12.8	25	1	5	25	8
11 Amelanchier alnifolia	80.0	16.4	1	1	30		50
12 Rubus paracaulis	60.0	7.2	10	1		25	
Populus tremuloides	60.0	3.0	1	10		4	
13 Berberis repens	60.0	2.0	4			5	1
14 Ribes lacustre	60.0	0.6	1	1		1	
15 Spiraea betulifolia(lucida	40.0	2.2		1		10	
16 Shepherdia canadensis	40.0	0.4		1			1
17 Juniperus communis	20.0	2.0		10			
Abies lasiocarpa	20.0	0.6		3			
Acer glabrum	20.0	0.2		1			
18 Juniperus horizontalis	20.0	0.2		1			
Pinus contorta	20.0	0.2		1			
Populus balsamifera ssp. t	20.0	0.2		1			
19 Rosa woodsii	20.0	0.2	1				
20 Rubus idaeus(strigosus)	20.0	0.2		1			
C LAYER							
21 Geranium viscosissimum	80.0	2.6	1		5	2	5
22 Fragaria virginiana	80.0	2.2	1		4	2	4
23 Erythronium grandiflorum	80.0	1.2	3		1	1	1
24 Osmorhiza chilensis	60.0	7.0	25		5		5
25 Thalictrum occidentale	60.0	3.8	10		8		1
26 Aster conspicuus	60.0	2.6			1	2	10
27 Achillea millefolium	60.0	0.6		1	1		1
28 Actaea rubra	40.0	2.6	10			3	
29 Artemisia tridentata	40.0	1.2		5			1
30 Galium boreale	40.0	1.0				1	4
31 Hackelia jessicae	40.0	1.0				1	4
32 Smilacina racemosa	40.0	1.0	1			4	
33 Viola canadensis(rugulosa)	40.0	0.8	1			3	
34 Calochortus apiculatus	40.0	0.4		1			1
35 Epilobium angustifolium	40.0	0.4		1		1	

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

POPULUS

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 009	SCSL 014	SCSL 020	SCSL 021	SCSL 025
NUMBER OF SPECIES PER PLOT	27.6		25	48	15	26	24
SPECIES	%P	MC	%C	%C	%C	%C	%C
36 Lathyrus ochroleucus	40.0	0.4	1			1	
37 Penstemon confertus	40.0	0.4		1			1
38 Potentilla gracilis	40.0	0.4		1			1
39 Smilacina stellata	40.0	0.4	1			1	
40 Arctostaphylos uva-ursi	20.0	2.0		10			
41 Aquilegia flavescens	20.0	1.0	5				
42 Ceanothus velutinus	20.0	0.4		2			
43 Lupinus sericeus	20.0	0.4					2
44 Penstemon albertinus(viren	20.0	0.4		2			
45 Antennaria anaphaloides	20.0	0.2				1	
46 Apocynum androsaemifolium	20.0	0.2		1			
47 Castilleja miniata	20.0	0.2					1
48 Clematis occidentalis(vert	20.0	0.2				1	
49 Cryptogramma acrostichoide	20.0	0.2		1			
50 Eriogonum umbellatum v. su	20.0	0.2		1			
51 Heracleum lanatum	20.0	0.2	1				
52 Heuchera cylindrica	20.0	0.2		1			
53 Lomatium dissectum	20.0	0.2				1	
54 Lomatium triternatum	40.0	0.4			1		1
Populus tremuloides	20.0	0.2		1			
55 Potentilla glandulosa	20.0	0.2					1
56 Pyrola chlorantha(virens)	20.0	0.2		1			
57 Ranunculus uncinatus	20.0	0.2				1	
58 Sedum lanceolatum	20.0	0.2		1			
59 Senecio integerrimus	20.0	0.2			1		
60 Solidago missouriensis	20.0	0.2		1			
61 Veratrum eschscholtzii	20.0	0.2				1	
62 Woodsia scopulina	20.0	0.2		1			
D LAYER							
63 Agropyron trachycaulum v.	40.0	1.2		1			5
64 Carex sp.	20.0	3.0					15
65 Carex deflexa	20.0	0.2		1			
66 Carex macloviana	20.0	0.2			1		
67 Elymus innovatus	20.0	0.2	1				
EX LAYER							
68 Grimmia sp.	20.0	0.2		1			
EL LAYER							
69 Umbilicaria sp.	20.0	5.0		25			
70 Lecanora sp.	20.0	3.0		15			
71 Lecidia sp.	20.0	3.0		15			
72 Rhizocarpon geographicum	20.0	1.0		5			
73 Umbilicaria mam	20.0	0.2		1			
	20.0	0.2		1			

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

ROCKLAND & SHRUBLAND

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 019	SCSL 016	SCSL 008	SCSL 007	SCSL 005	SCSL 002	SCSL 024
NUMBER OF SPECIES PER PLOT	26.9		15	19	35	32	22	43	22
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C	%C
A1 LAYER									
1 Abies lasiocarpa	14.3	0.3	2						
2 Pinus albicaulis	14.3	0.3	2						
3 Picea engelmannii	14.3	0.1	1						
B2 LAYER									
4 Potentilla fruticosa	71.4	1.7		1	8	1	1	1	
5 Juniperus communis	57.1	2.6	5	1	10	2			
6 Amelanchier alnifolia	42.9	0.6		1	2				1
7 Symphoricarpos albus	28.6	0.9				5		1	
8 Rosa woodsii	28.6	0.7			3	2			
9 Rosa acicularis	28.6	0.3		1					1
10 Rubus idaeus(strigosus)	28.6	0.3		1				1	
11 Juniperus horizontalis	14.3	0.3						2	
12 Acer glabrum	14.3	0.1		1					
13 Pinus contorta	14.3	0.1			1				
14 Populus tremuloides	14.3	0.1		1					
15 Prunus virginiana	14.3	0.1		1					
C LAYER									
16 Galium boreale	71.4	1.4		1	3	3		2	1
17 Heuchera cylindrica	71.4	1.4	1		2	2		1	4
18 Achillea millefolium	71.4	0.9			2	1	1	1	1
19 Antennaria parvifolia(niti	57.1	1.0			1	2		3	1
20 Calochortus apiculatus	57.1	0.9			1	1		3	1
21 Eriogonum umbellatum v. su	57.1	0.9			2	1		3	.5
22 Selaginella densa	42.9	1.9			8		1	4	
23 Penstemon albertinus(viren	42.9	1.0		1	4			2	
24 Antennaria umbrinella	42.9	0.6					1	2	1
25 Arctostaphylos uva-ursi	42.9	0.4	1	1				1	
26 Geum triflorum	42.9	0.4					1	1	1
27 Penstemon confertus	42.9	0.4				1		1	1
28 Sedum lanceolatum	42.9	0.4				1		1	1
29 Woodsia scopulina	42.9	0.4				1		1	1
30 Artemisia tridentata	28.6	7.1						5	45
31 Lupinus sericeus	28.6	1.6				10			1
32 Epilobium angustifolium	28.6	0.4				2		1	
33 Allium cernuum	28.6	0.3			1				1
34 Anemone multifida	28.6	0.3		1	1				
35 Astragalus americanus(frig	28.6	0.3		1	1				
36 Campanula rotundifolia	28.6	0.3			1		1		
37 Cryptogramma acrostichoide	28.6	0.3	1					1	
38 Saxifraga bronchialis	28.6	0.3	1					1	
39 Sedum stenopetalum	28.6	0.3			1			1	
40 Stellaria longifolia	28.6	0.3			1			1	
41 Taraxacum officinale	28.6	0.2			1				.5
Amelanchier alnifolia	14.3	2.6				18			
42 Shepherdia canadensis	14.3	2.6			18				
43 Selaginella densa	14.3	2.1							15
44 Gaillardia aristata	14.3	1.1			8				

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

ROCKLAND & SHRUBLAND

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 019	SCSL 016	SCSL 008	SCSL 007	SCSL 005	SCSL 002	SCSL 024
NUMBER OF SPECIES PER PLOT	26.9		15	19	35	32	22	43	22
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C	%C
45 Solidago missouriensis	14.3	0.9			6				
46 Artemisia michauxiana	14.3	0.7						5	
47 Dryas octopetala	14.3	0.7					5		
Symphoricarpos albus	14.3	0.7				5			
48 Geranium viscosissimum	14.3	0.6				4			
49 Oxytropis splendens	14.3	0.6			4				
50 Oxytropis cusickii(campest	14.3	0.4			3				
Juniperus communis	14.3	0.3				2			
Rosa woodsii	14.3	0.3				2			
51 Antennaria alpina	14.3	0.1					1		
52 Apocynum androsaemifolium	14.3	0.1						1	
53 Artemisia campestris	14.3	0.1					1		
54 Aster alpinus	14.3	0.1					1		
55 Astragalus vexilliflexus	14.3	0.1		1					
56 Balsamorhiza sagittata	14.3	0.1						1	
57 Ceanothus velutinus	14.3	0.1			1				
58 Cerastium arvense	14.3	0.1							1
59 Cerastium nutans	14.3	0.1				1			
60 Cirsium hookerianum	14.3	0.1				1			
61 Claytonia lanceolata	14.3	0.1	1						
62 Fragaria virginiana	14.3	0.1				1			
63 Hackelia jessicae	14.3	0.1				1			
64 Lomatium dissectum	14.3	0.1						1	
65 Minuartia nuttallii(Arenar	14.3	0.1					1		
66 Minuartia obtusiloba(Arena	14.3	0.1					1		
67 Minuartia rubella(Arenaria	14.3	0.1					1		
68 Myosotis alpestris	14.3	0.1					1		
69 Orobanche uniflora	14.3	0.1						1	
70 Osmorhiza chilensis	14.3	0.1				1			
71 Penstemon ellipticus	14.3	0.1	1						
72 Penstemon eriantherus	14.3	0.1							1
73 Penstemon sp.	14.3	0.1						1	
74 Phacelia hastata(heterophy	14.3	0.1						1	
75 Phacelia sericea	14.3	0.1			1				
76 Polemonium pulcherrimum	14.3	0.1			1				
Potentilla fruticosa	14.3	0.1				1			
77 Potentilla glandulosa	14.3	0.1						1	
78 Potentilla gracilis	14.3	0.1							1
79 Senecio canus	14.3	0.1		1					
80 Senecio integerrimus	14.3	0.1				1			
81 Smilacina racemosa	14.3	0.1			1				

LEVEL	ZONE	ASSC	TYPE
ECOSYM UNIT	RKYMTN	1	

ROCKLAND & SHRUBLAND

PRESENCE (%P), MEAN COVER (MC), PERCENT COVER (%C)

PLOT NUMBER	AVERAGE VALUE		SCSL 019	SCSL 016	SCSL 008	SCSL 007	SCSL 005	SCSL 002	SCSL 024
NUMBER OF SPECIES PER PLOT	26.9		15	19	35	32	22	43	22
SPECIES	%P	MC	%C	%C	%C	%C	%C	%C	%C
82 Zigadenus venenosus	14.3	0.1		1					
D LAYER									
83 Agropyron dasystachyum	71.4	12.6		1	1	60		25	1
84 Festuca sp.	28.6	1.7				5		7	
85 Stipa columbiana	28.6	0.4			1			2	
86 Bromus inermis	28.6	0.3		1			1		
87 Calamagrostis purpurascens	28.6	0.3		1			1		
88 Carex macloviana	28.6	0.3			1			1	
89 Koeleria macrantha	28.6	0.3			1			1	
90 Festuca rubra	14.3	0.4			3				
91 Agropyron violaceum	14.3	0.1					1		
92 Festuca brachyphylla	14.3	0.1					1		
93 Festuca idahoensis	14.3	0.1						1	
94 Juncus drummondii	14.3	0.1	1						
95 Poa alpina	14.3	0.1					1		
96 Poa canby-	14.3	0.1					1		
97 Poa iterior	14.3	0.1					1		
98 Poa sanbergii	14.3	0.1					1		
99 Sisyrinchium montanum	14.3	0.1			1				
EX LAYER									
100 Grimmia sp.	14.3	0.4						3	
101 Tortula sp.	14.3	0.3						2	
EL LAYER									
102 Leconora sp.	42.9	1.9	5			1		7	
103 Lecidia sp.	42.9	1.6	5			1		5	
104 Rizocarpon sp.	28.6	1.6	10			1			
105 Umbilicalia sp.	28.6	1.4	5					5	

APPENDIX II
ENVIRONMENTAL DATA TABLES

ENVIRONMENT/SOILS-VEGETATION TABLES
TITLE : RKYMTN 1 PINUS CONTORTA

	MEAN	SCS L001	SCS L006	SCS L010	SCS L011	SCS L012	SCS L013	SCS L017	SCS L018	SCS L023
PLOT NUMBER										
TOWNSHIP & RANGE		0403	0403	0403	0403	0403	0403	0403	0403	0403
MERIDIAN		W 5	W 5	W 5	W 5	W 5	W 5	W 5	W 5	W 5
MAPSHEET		82 G 8	82 G 8	82 G 8	82 G 8	82 G 8	82 G 8	82 G 8	82 G 8	82 G 8
PHYSIOGRAPHIC SUBREGION										
GEOMORPHIC SYSTEM										
ECOSECTION										
ELEVATION(MASL)	1602.6	1707	1555	1890	1524	1518			1524	1500
SLOPE(%)	31.6	50	8	60	20	25	40		25	25
ASPECT(DEG)		183	240	220	214	200	220		220	230
ENVIRONMENT/SOILS :										
ECOLOGICAL MOISTURE REGIME		SX	M	X	SM	M	SX	M	M	SX
SOIL DRAINAGE		R	W	R	W	W	W	MW	W	R
VEGETATION :										
ASSOCIATION										
STAND AGE(YR)	0.0									
CANOPY HEIGHT(M)	0.0									
MEAN ANNUAL INCREMENT	0.0									
STRATA COVERAGE(%)-A	31.9	17	30	0	50	55	50	50	15	20
-B	6.2	3	2	25	10	1	1	2	2	10
-C	46.7	25	60	5	60	80	60	0	80	50
-G	2.1	7	8	1	0	1	1	0	0	1
-D	1.1	0	0	0	0	0	0	0	0	10
-L	8.3	30	0	45	0	0	0	0	0	0
SURFACE SUBST(%)-DEAD WOOD	1.3	1	1	1	1	1	1	1	4	1
-BEDROCK	3.1	2	0	10	1	0	0	5	0	10
-STONES	19.1	75	1	60	5	0	5	0	1	25
-MIN.SOIL	4.8	1	0	27	5	0	0	0	0	10
-ORGANIC	72.3	21	99	2	90	99	95	95	95	55
-OPEN WATER	0.0	0	0	0	0	0	0	0	0	0
BIOMASS(KG/HA)-FORBS	0.0									
-GRAMINOIDS	0.0									
-BROWSE	0.0									

ENVIRONMENT/SOILS-VEGETATION TABLES
TITLE : RKYMTN 1 ABIES-PINUS

	MEAN	SCS L003 0403 W 5 82 G 8	SCS L015 0403 W 5 82 G 8	SCS L022 0403 W 5 82 G 8	SCS L026 0403 W 5 82 G 8	SCS L027 0403 W 5 82 G 8	SCS L004 0403 W 5 82 G 8
PLOT NUMBER							
TOWNSHIP & RANGE							
MERIDIAN							
MAPSHEET							
PHYSIOGRAPHIC SUBREGION							
GEOMORPHIC SYSTEM							
ECOSECTION							
ELEVATION(MASL)	1931.8	1737	2042	1920	1950	2010	
SLOPE(%)	59.0	55	60	55	50	75	
ASPECT(DEG)		360	270	100	130	200	
ENVIRONMENT/SOILS :							
ECOLOGICAL MOISTURE REGIME		M	X	SHG	SX	X	M
SOIL DRAINAGE		MW	R	MW	R	R	W
VEGETATION :							
ASSOCIATION							
STAND AGE(YR)	0.0						
CANOPY HEIGHT(M)	0.0						
MEAN ANNUAL INCREMENT	0.0						
STRATA COVERAGE(%)-A	32.7	36	0	65	30	30	35
-B	18.0	40	45	3	0	0	20
-C	28.8	3	5	50	25	10	80
-G	1.2	0	1	1	0	1	4
-D	0.2	1	0	0	0	0	0
-L	4.2	0	0	0	25	0	0
SURFACE SUBST(%)-DEAD WOOD	4.5	20	0	1	1	0	5
-BEDROCK	4.7	1	0	1	5	20	1
-STONES	28.7	5	70	1	15	80	1
-MIN. SOIL	18.7	1	30	0	80	0	1
-ORGANIC	45.7	75	0	99	5	0	95
-OPEN WATER	0.0	0	0	0	0	0	0
BIOMASS(KG/HA)-FORBS	0.0						
-GRAMINOIDS	0.0						
-BROWSE	0.0						

ENVIRONMENT/SOILS-VEGETATION TABLES
TITLE : RKYMTN 1 POPULUS

	MEAN	SCS L009 0403 W 5 82 G 8	SCS L014 0403 W 5 82 G 8	SCS L020 0403 W 5 82 G 8	SCS L021 0403 W 5 82 G 8	SCS L025 0403 W 5 82 G 8
PLOT NUMBER						
TOWNSHIP & RANGE						
MERIDIAN						
MAPSHEET						
PHYSIOGRAPHIC SUBREGION						
GEOMORPHIC SYSTEM						
ECOSECTION						
ELEVATION(MASL)	1616.4	1524	1768	1650	1460	1680
SLOPE(%)	28.0	20	45	30	10	35
ASPECT(DEG)		180	210	220	220	220
ENVIRONMENT/SOILS :						
ECOLOGICAL MOISTURE REGIME		M	X	M	M	M
SOIL DRAINAGE		MW	R	W	W	W
VEGETATION :						
ASSOCIATION						
STAND AGE(YR)	0.0					
CANOPY HEIGHT(M)	0.0					
MEAN ANNUAL INCREMENT	0.0					
STRATA COVERAGE(%)-A	36.2	95	0	1	85	0
-B	34.0	1	20	75	9	65
-C	68.0	85	30	55	80	90
-G	4.6	1	1	1	0	20
-D	0.2	0	1	0	0	0
-L	12.0	0	60	0	0	0
SURFACE SUBST(%)-DEAD WOOD	2.0	1	0	1	3	5
-BEDROCK	1.4	0	5	1	0	1
-STONES	18.4	0	90	1	0	1
-MIN.SOIL	1.6	0	5	1	1	1
-ORGANIC	78.0	100	0	98	97	95
-OPEN WATER	0.0	0	0	0	0	0
BIOMASS(KG/HA)-FORBS	0.0					
-GRAMINOIDS	0.0					
-BROWSE	0.0					

ENVIRONMENT/SOILS-VEGETATION TABLES
TITLE : RKYMTN 1 ROCKLAND & SHRUBLAND

	MEAN	SCS L019 0403 W 5 82 G 8	SCS L016 0403 W 5 82 G 8	SCS L008 0403 W 5 82 G 8	SCS L007 0403 W 5 82 G 8	SCS L005 0403 W 5 82 G 8	SCS L002 0403 W 5 82 G 8	SCS L024 0403 W 5 82 G 8
PLOT NUMBER								
TOWNSHIP & RANGE								
MERIDIAN								
MAPSHEET								
PHYSIOGRAPHIC SUBREGION								
GEOMORPHIC SYSTEM								
ECOSECTION								
ELEVATION(MASL)	1811.7	1920	1768	1615	1676	2164	1859	1680
SLOPE(%)	41.4	75	70	35	35	10	30	35
ASPECT(DEG)		185	210	204	220	360	180	220
ENVIRONMENT/SOILS :								
ECOLOGICAL MOISTURE REGIME		X	VX	SX	M	X	X	SX
SOIL DRAINAGE		R	R	R	W	R	R	W
VEGETATION :								
ASSOCIATION								
STAND AGE(YR)	0.0							
CANOPY HEIGHT(M)	0.0							
MEAN ANNUAL INCREMENT	0.0							
STRATA COVERAGE(%)-A	0.7	5	0	0	0	0	0	0
-B	0.7	5	0	0	0	0	0	0
-C	34.1	6	5	80	45	8	30	65
-G	15.4	0	1	5	65	1	35	1
-D	0.9	0	0	0	0	0	6	0
-L	6.6	25	0	0	1	0	20	0
SURFACE SUBST(%)-DEAD WOOD	0.6	1	0	1	1	0	1	0
-BEDROCK	5.6	5	5	1	1	1	25	1
-STONES	47.1	95	95	5	5	100	25	5
-MIN.SOIL	44.0	1	0	92	95	0	50	70
-ORGANIC	4.3	1	0	3	0	0	1	25
-OPEN WATER	0.0	0	0	0	0	0	0	0
BIOMASS(KG/HA)-FORBS	0.0							
-GRAMINOIDS	0.0							
-BROWSE	0.0							

APPENDIX III

DRAFT TERMS OF REFERENCE
VEGETATION, FLORA, AND SPECIAL FEATURES
OF THE PROPOSED SOUTHCASTLE NATURAL AREA

1. INTRODUCTION

The proposed Southcastle Natural Area is one square mile in size, located in southwestern Alberta. It has been proposed as a natural area because of the occurrence of several rare plant species, and of species that are of restricted distribution in Alberta.

Detailed information on the vegetation and flora of the site is required, with emphasis to be placed on the identification of special features and of rare plant species present. In addition, recommendations for management of the site are required with the objective of maintaining rare species and special features. Present and potential management problems should be identified.

It is anticipated that this study will require both detailed field work and extensive literature review.

2. PURPOSE

General:

- do a detailed vegetation survey of the proposed Southcastle Natural Area
- document rare species and special features present
- identify management concerns
- make recommendations for management of the site to ensure maintenance of the special features and rare species present

Specific:

1. produce a draft map of the major vegetation types at a scale of 1:15,000 on mylar
2. produce a draft map of disturbances present at a scale of 1:15,000 mylar
3. produce a draft map of the special features at a scale of 1:15,000 on mylar

4. produce a draft map of the extent of the Artemisia tridentata communities within and adjacent to the proposed natural area

5. document the diversity of the Artemisia tridentata stands both within and adjacent to the natural area

6. provide an annotated vascular floral species list

7. provide a labelled and unmounted collection of the uncommon and rare vascular flora

8. provide a labelled collection of non-vascular flora

9. provide a complete set of field data sheets (see attached example) for the vegetation plots examined

10. provide an annotated list of faunal species noted

11. identify present and potential management problems

12. based on literature review; make recommendations on the management techniques required to ensure the long term maintenance of special features and rare species present. Of special concern is maintenance of the Artemisia tridentata communities

13. provide a descriptive report

3. DEFINITIONS

1. Special features may include but not be limited to:

   - excellent or "classic" examples of geomorphic features or vegetation types
   - rare or unusual physical or biological features
   - areas of exceptional biophysical diversity
   - important faunal habitats
   - areas particularly sensitive to disturbance

2. Representative features include physical or biological features common to the biogeographical section.

3. Rare or uncommon plants include those species listed in "A Checklist of the Rare Vascular Plants of Alberta with Maps" (J. G. Packer and C. Bradley 1978).

4. Final Draft Report refers to a typed or written report that is submitted for professional and editorial comment and that in content, structure and quality conforms to Alberta Energy and Natural Resources standards for a departmental publication (see Creating a Technical Report, Alberta Energy and Natural Resources). See attachment.

5. Final Report refers to the corrected version of the Final Draft Report and should be fully satisfactory to the Minister.

4. PROJECT AREA

The area includes the 260 ha (one sq.mi.) proposed natural area. The lands included are Twp. 4 - Rge. 3 - W5: Section 24 (see attached map).

5. MAPPING REQUIREMENTS

The maps will be prepared using aerial photograph interpretation and ground truthing.

The maps will be prepared on mylar and be professionally adequate in presentation and quality that they could, at the discretion of the Natural Areas Co-ordinator, be easily redrafted by professional cartographers/draftsmen using provincial base maps.

6. FIELD REQUIREMENTS

Based on preliminary aerial photograph interpretation, the contractor will conduct fieldwork between May 20 and August 30, 1985. The timing of fieldwork is at the consultant's discretion but will consider phenologies of the biological resources involved. Specifically but not limited to flowering plants and nesting birds.

The methodologies for vegetation typing in the field are at the consultant's discretion, but must be sufficiently rigorous and comprehensive to allow documented description of the full range of plant communities within a vegetation mapping unit.

7. REPORT REQUIREMENTS

The report will include a description of the study area, based on literature reviews, and may include such topics as bedrock and surficial geology, climate, soils, fauna, etc. It will discuss in detail any special features present.

The report will contain all pertinent information regarding descriptions of the vegetation types found and mapped in the study area. This information will include but not be limited to a list of dominant as well as characteristic plant species for each type, a description of the physical parameters which characterize the type, and a description of the range of diversity of stands which the consultant recognized as occurring within each type.

The diversity of Artemisia tridenta communities should be fully documented, and the extent of those communities both within and adjacent to the proposed natural area clearly delineated. Recommendations for boundary changes to the proposed natural area should be made if appropriate. The report will also include a detailed discussion on management issues and recommendations for this site. It will identify, based on literature review, any specific management techniques required to ensure maintenance of the special or rare features in the area.

8. LOGISTIC SUPPORT

The consultant will supply all material and equipment required for completion of the study, with the exception of:

- provincial base maps (1:15,000) for mapping of vegetation and special features
- mylar
- film
- aerial photographs
- typing service
- identification of the vascular and non-vascular flora
- blank field data sheets

9. COMPLETION SCHEDULE

The consultant shall submit:

1. a field itinerary no later than June 15, 1985.
2. a final draft report and maps no later than November 30, 1985 (see DEFINITIONS).
3. a final report and maps no later than January 31, 1986 (see DEFINITIONS).

10. LIAISON

The consultant shall maintain a close liaison with Natural Areas Program staff, and shall arrange for the work to be reviewed and/or discussed at critical points in the project. At a minimum, this will include a review following the completion of each phase of the project as in Section 9 above.

11. CONTRACT

The consultant must sign a contract similar to attached example. Holdbacks will be required until a final report is submitted.

12. REQUIRED QUALIFICATIONS

- the contractor must have extensive experience in conducting biophysical surveys in grasslands

- the contractor must have experience in the identification and management of rare and special biophysical features

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